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Opuscula Philolichenum

small works in the field of lichenology

EDITOR:

JAMES C. LENDEMER
Cryptogamic Herbarium
Institute of Systematic Botany
The New York Botanical Garden
Bronx, NY 10458-5126, U.S.A.
e-mail: jlendemer@nybg.org

ASSOCIATE EDITORS:

KERRY KNUDSEN
The Herbarium
Dept. of Botany & Plant Sciences
The University of California, Riverside
Riverside, CA 92521-0124, U.S.A.
e-mail: kk999@msn.com

CALEB A. MORSE
R.L. McGregor Herbarium
Division of Botany
Biodiversity Research Center, University of Kansas
2045 Constant Ave., Lawrence, KS 66047, U.S.A.
e-mail: cmorse@ku.edu

MISSION

Opuscula Philolichenum is intended to serve as a venue for the publication of small works in the field of lichenology (including lichenicolous fungi and non-lichenized fungi traditionally treated with lichens). The central goal of the journal is to provide timely publication, in a professional format, free of charge to authors and readers. While the journal focuses on topics relating to the lichen biota of North America this is by no means exclusive and manuscripts on other topics will be considered as the table of contents of the present issue clearly illustrates.

Authors wishing to submit a manuscript for publication in *Opuscula Philolichenum* should contact the editor prior to submission to confirm that the paper conforms to the mission of the journal (outlined above). Manuscript submissions should be left unformatted and authors should consult a recent issue of *Opuscula Philolichenum* for style. All submissions are subjected to review by at least two peer reviewers and, following acceptance are formatted by the editor.

NOTICE FROM THE EDITOR

When this journal began publication ten years ago it was among the first serials to take advantage of the internet when publishing new botanical nomenclatural acts. The journal was conceived as a primarily electronic one, available on-line free of charge (at http://sweetgum.nybg.org/philolichenum/), with a limited print run to satisfy the requirements for effective publication established under the *International Code for Botanical Nomenclature*. Since that time we have continued to publish the journal in this manner, printing one or two issues a year, with each issue consisting of between one and two hundred pages.

In 2004 we could not have foreseen the revolutionary changes that took place at the 18th International Botanical Congress in Melbourne. There the Nomenclature Section voted to allow electronic only publication of new nomenclatural acts beginning 1 January 2012. In response to this change *Opuscula Philolichenum* no longer produces hardcopy. Although a single printed copy will continue to be deposited in the library of The New York Botanical Garden.

Beginning with volume (number 12) of *Opuscula Philolichenum*, manuscripts are published electronically on-line in PDF/A format immediately following the approval of the authors in the post-review proof stage. The PDF issued online is considered to be the final version (= version of record) and the date on which the PDF is posted is considered to be the date of effective publication. In order to aid future workers the date of effective publication for each manuscript is provided in the table of contents. When a new manuscript is published online a record is also simultaneously transmitted to the organizers of *Recent Literature on Lichens* for inclusion in that database.

THANKS TO OUR REVIEWERS

As with all previous issue of *Opuscula Philolichenum* the backbone of a journal is its cohort of reviewers. Therefore we take this opportunity to thank those researchers who have generously agreed to review manuscripts submitted for consideration in the journal in 2013: Teuvo Ahti – Helsinki, Finland; Irwin M. Brodo – Ottawa, Canada; Paul Diederich – Luxembourg; Jack Elix – Canberra, Australia; Damien Ertz – Belgium; Javier Etayo – Navarro, Spain; Richard C. Harris – Bronx, U.S.A.; David Hawksworth – Madrid, Spain & London, U.K.; Martin Kukwa – Gdansk, Poland; Doug Ladd – St. Louis, U.S.A.; Keith Langdon – Tennessee, U.S.A.; R. Troy McMullin – Guelph, Canada; Anders Nordin – Uppsala, Sweden; Harrie Sipman – Berlin, Germany; Göran Thor – Stockholm, Sweden; Tor Tønsberg – Bergen, Sweden; Mikhail Zhurbenko – St. Petersburg, Russia

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Isthmoconidium bacidiicola, a new genus and species of lichenicolous hyphomycetes on *Bacidia* from Bermuda

JAVIER ETAYO[1] & FRANZ BERGER[2]

ABSTRACT. – The new genus *Isthmoconidium* with its type species *I. bacidiicola*, growing on thalli of the corticolous lichen *Bacidia heterochroa* in the Bermudas, is described and illustrated. Very small conidiomata, polyblastic conidiogenous cells and violaceous conidia composed of two cells linked by a thin isthmus or with one cell plugged into the other cell are characteristic features of the new genus.

KEYWORDS. – Taxonomy, anamorphic fungi, lichen, Caribbean.

INTRODUCTION

The second author spent some weeks in 2007 collecting lichens and lichenicolous fungi on the Bermudas. Nearly 180 species of lichens and eleven lichenicolous species were recorded hitherto from this tiny archipelago of only 55 km² (LaGreca & Berger 2008), some of them new to science (e.g. Aptroot et al. 2008, Berger & Aptroot 2008).

Among the material gathered during this fieldwork was one lichenicolous fungus with very small pycnidioid conidiomata on thalli of *Bacidia heterochroa* (Müll. Arg.) Zahlbr. Its characteristic coloured, two-celled conidia with a very constricted septum, combined with its manner of conidiogenesis are unique and warrant a description as a new species. As we have not found any suitable genus for this fungus, we also propose to place it in a new genus named *Isthmoconidium*.

MATERIAL AND METHODS

This study is based on specimens collected in 2007 by the second author, deposited in LI and the private herbaria of both authors. The specimens were examined with a Nikon Eclipse 80i (DIC) stereomicroscope and an Olympus BX50 compound microscope with interference contrast. The habit photos were made by Erich Zimmermann with a dissecting microscope (Leica M165C) equipped with a Jenoptik ProgResC5-CCD camera. A transmission light microscope (Leica DMLS2) equipped with a Jenoptik ProgResC7 camera was used to obtain the photographs of microscopic morphological features. Better depth of focus was achieved by use of the free stacking software LAS V3.7. Microscope sections were cut by hand and mounted in water. The measurements of microscopic details were made in water. The terminology used for morphological characters follows Seifert et al. (2011).

TAXONOMIC SECTION

***Isthmoconidium* Etayo & F. Berger, gen. nov.**
Mycobank #803515.

TYPE: ***Isthmoconidium bacidiicola* Etayo & F. Berger**

FIGURES 1 AND 2.

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[1] JAVIER ETAYO – Navarro Villoslada 16, 3° dcha., 31003 Pamplona, Navarra, Spain. – e-mail: jetayosa@educacion.navarra.es
[2] FRANZ BERGER – Raiffeisenweg 130, 4794 Kopfing, Austria. – e-mail: flechten.berger@aon.at

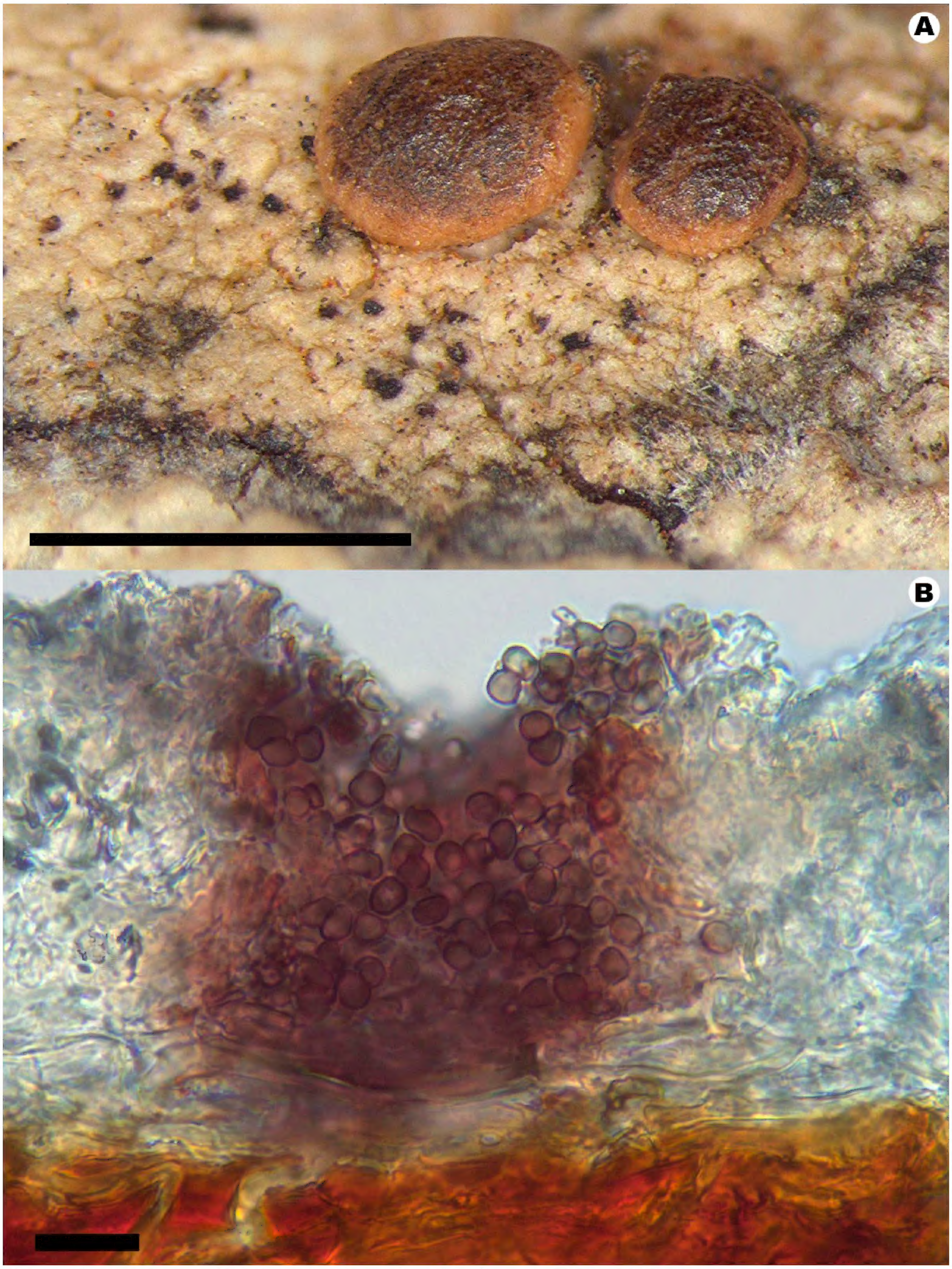

Figure 1, holotype of *Isthmoconidium bacidiicola*. A, habit of the fungus illustrating the black sporodochia on the thallus of the host, *Bacidia heterochroa* (scale = 0.5 mm). B, vertical section through a partially immersed sporodochium where the uppermost portion has been eroded (scale = 10 µm).

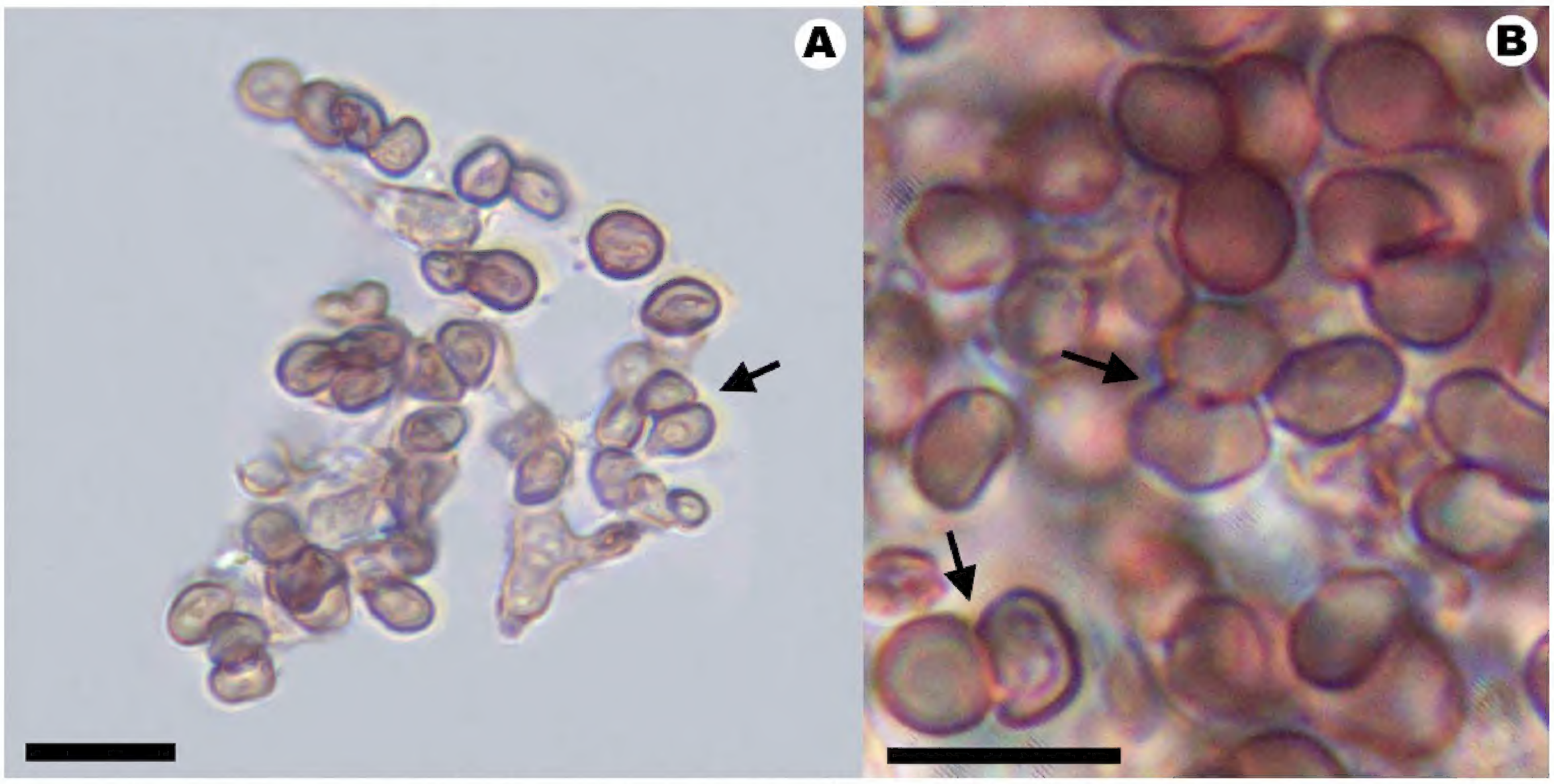

Figure 2, conidia and conidiophores of *Isthmoconidium bacidiicola* (both from the holotype). A, conidiophores with conidiogenous cells and 2-celled conidia (scale = 10 µm). B, variation in conidia (scale = 10 µm). In this figure arrows point to typical conidia.

DESCRIPTION. – Lichenicolous anamorphic fungus. **Conidiomata** punctiform, black, young immersed and with pycnidioid or pseudocupulate appearance, but without stromatic wall, becoming finally slightly erumpent. **Conidiophores** hyaline to slightly violaceous, irregularly branched, multiseptate. **Conidiogenous cells** usually polyblastic, integrated into chains, acro-pleurogenous, hyaline to violaceous, cylindrical to clavate. **Conidia** formed by 2 (aberrantly 3 or 4) somewhat inflated cells linked by a thin isthmus or with one cell plugged into the other cell, violaceous to violaceous-brown and with a thin, smooth wall.

ETYMOLOGY. – *Isthmoconidium*, derived from the Greek word ισθμός = neck, land bridge, referring to the paired cells forming a single conidium, connected by a tiny bridge.

Isthmoconidium bacidiicola **Etayo & F. Berger, sp. nov.**
Mycobank #803516.

TYPE: **THE BERMUDAS. SMITH PARISH:** edge of the sinkhole "Sears Cave", 20 m alt., 32°18′41"N 64°44′12"W, on thallus of *Bacidia heterochroa* on bark of *Celtis laevigata*, 3.xi.2007, *F. Berger 22323 & S. LaGreca* (LI!, holotype; hb. Etayo!, isotype).

DESCRIPTION. – **Vegetative hyphae** immersed, light brown, septate, sparse, 2-3 µm thick, toruloid, with smooth and thin walls. **Conidiomata** punctiform, very small, 20-50 µm diam., black, young immersed and with pycnidioid to pseudocupulate appearance, becoming finally irregular, slightly erumpent, arising singly, scattered. The contact zone of the pycnidioid base is separated from the host tissue by an indiscernible hyaline layer, 4-5 µm thick, produced reactively by the cortex of the host. **Conidiophores** hyaline to slightly violaceous, irregularly branched, multiseptate, thin-walled, smooth. **Conidiogenous cells** holoblastic, with conidia arising from the apical or lateral parts, mostly polyblastic with 4-5 loci around the upper half of the conidiogenous cell, hyaline to violaceous, cylindrical to clavate, mainly 4-5 × 1-3 µm, with long channel and indistinct collarette. **Conidia** formed acropleurogenously, solitary, violaceous to violaceous-brown, thin-walled, smooth, usually composed of two irregularly subspherical, ellipsoid or pyriform cells (didymoconidia), which are linked together in different ways, either connected by a thin isthmus with an indistinct transversal septum, or the lower cell plugged into the upper like the stem into the cap of a *Boletus*, septum not always visible; with one large guttule inside each cell, cells (2.5-)3-3.5(-4.5) × (2-)3-3.5 µm, whole conidia 5-8 × (2-)3-3.5 µm (n=40), rarely consisting of 3-

4 cells, then lobed; one cell of the pair sometimes with a little paraxial denticle representing the insertion to the conidiogenous cell; secession schizolytic.

ETYMOLOGY. – The epithet "bacidiicola" or, inhabitant of *Bacidia*, refers to the exclusive infection of this host amidst a mosaic of other crustose lichens.

ECOLOGY AND DISTRIBUTION. – Although the infection of *Isthmoconidium* can minimally darken the host thallus due to its brown immersed hyphae, usually the injury is not visible and the lichen produces apparently healthy apothecia. Therefore, the new taxon seems to be a parasymbiont or a weak parasite. To date the taxon has been found only at the type locality, growing on thalli of *Bacidia heterochroa* on thin branches in a shrubbery of young *Celtis laevigata*.

This tree is an excellent substrate for crustaceous lichens, and the following species were found together with the new taxon at the type locality: *Amandinea insperata* (Nyl.) H. Mayrhofer & Sheard, *Arthonia* (four spp.), *Baculifera micromera* (Vain.) Marbach, *Graphis tenella* Ach., *Haematomma persoonii* (Fée) A. Massal., *Hafellia disciformis* Marbach & H. Mayrhofer and *Lecanora caesiorubella* Ach., *L. chlaronella* Nyl., *L. helva* Stizenb., *Pertusaria xanthodes* Müll. Arg., *Phaeographis dendritica* (Ach.) Müll. Arg., *P. inusta* (Ach.) Müll. Arg., *Porina cestrensis* (Tuck.) Müll. Arg., *P. isidiata* Kalb & Hafellner, *P. leptalea* (Durieu & Mont.) A.L. Sm.

The following lichenicolous fungi were also found with the new taxon at the type locality: "*Endococcus*" *thalamita* Nyl. ex Crombie and *Laeviomyces pertusariicola* agg. on *Hafellia disciformis*, *Minutoexipula* sp. on *Amandinea insperata*, and an undescibed *Pyrenidium* on *Lecanora*.

The host lichen *Bacidia heterochroa* is not rare on the Bermudas and was encountered during fieldwork on the smooth bark of other trees including *Eugenia uniflora* L., *Rhizophora mangle* L., and *Nerium oleander* L. It is a widely distributed lichen, known from tropical and subtropical areas worldwide (Ekman 1996). Species of *Bacidia* host 18 species of lichenicolous fungi but *Isthmoconidium* is the only one known to occur on this genus on the Bermudas. Two other hyphomycetes known from *Bacidia* are *Ellisembia lichenicola* Heuchert & U. Braun (Heuchert & Braun 2006), and *Sporidesmium bacidiicola* Alstrup (Alstrup 1991).

DISCUSSION. – There are several genera of lichenicolous fungi with a conidiogenesis similar to that of *Isthmoconidium*. Some of these develop conidia inside pycnidia, like the coelomycetes *Cornutispora* Piroz. (Hawksworth 1981, Punithalingam 2003) or *Lichenosticta* Zopf (Hawksworth 1981). Others develop conidia in different structures such as in the hyphomycete *Fenestroconidia* Calat. & Etayo (Calatayud & Etayo 1999). The new genus differs from *Cornutispora* and *Lichenosticta* in the absence of a pycnidial wall and production of two-celled, violaceous-brown conidia with cells separated by a narrow isthmus (vs. triradiate, hyaline conidia in *Cornutispora* (Punithalingam 2003) and lacriform, hyaline conidia in *Lichenosticta* (Hawksworth 1981)). *Fenestroconidia* is a hyphomycete genus that grows on *Caloplaca saxicola* s. lat. Its conidia also differ significantly from those of *Isthmoconidium* in that they are pale brown, simple and of an ellipsoid or irregularly curved shape (Calatayud & Etayo 2000). The lichenicolous coelomycete *Diplolaeviopsis* also has conidia which could remind one of *Isthmoconidium*. However, *Diplolaeviopsis* differs from the new genus in having pycnidia with a true dark brown wall, conidiogenous cells that are subcylindrical with a small collarette, and acrogenous conidia that are strongly constricted at the septum and hyaline (Giralt & Hawksworth 1991).

Among the known genera of non-lichenicolous fungi the conidiogenous cells of the plant parasite *Hormonema* Lagerb. & Melin are similar to *Isthmoconidium*. But in that genus the conidiogenous cells have inconspicuous annellations, and with a single or two loci per cell. Furthermore, its conidia are hyaline, regularly ellipsoid, and mostly simple (Seifert et al. 2011).

Additional specimen examined. **- THE BERMUDAS. SMITH PARISH:** edge of the sinkhole "Sears Cave", 20 m alt., 32°18′41"N 64°44′12"W, on thallus of *Bacidia heterochroa* on bark of *Celtis laevigata*, 3.xi.2007, *F. Berger 22797 & S. LaGreca* (hb. Berger).

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Cave area. Wolfgang Sterrer (Bermuda Biological Station for Research) gave valuable assistance and sent additional material from the type locality to the second author. We kindly acknowledge the valuable additions of James Lendemer and two unknown reviewers. John Carter approved our manuscript for linguistic correctness. This is contribution number 205, Bermuda Biodiversity Project (BBP), Bermuda Aquarium, Natural History Museum and Zoo, Department of Conservation Services.

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New and interesting lichens from Ontario, Canada

RICHARD TROY MCMULLIN[1] & CHRISTOPHER J. LEWIS[2]

ABSTRACT. – Here we report 22 lichen species from 21 genera that are either new to the Canadian province of Ontario or are new records of provincially uncommon species. One species is new to Canada: *Hyperphyscia syncolla.* Three are new to Ontario: *Bryoria fremontii, Fulgensia bracteata* ssp. *bracteata,* and *Hypogymnia incurvoides.* Eighteen species are new reports of uncommon species: *Acrocordia cavata*, *Bacidina egenula, Chaenothecopsis exilis, C. haematopus, Candelaria fibrosa, Collema limosum, Evernia prunastri, Flavoparmelia baltimorensis, Heterodermia galactophylla, Leptogium hirsutum, Megaspora verrucosa, Microcalicium disseminatum, Myelochroa obessa, Psorotichia schaereri, Punctelia appalachensis, Rinodina pachysperma, Teloschistes chrysophthalmus,* and *Trypethelium virens*. Our records bring the number of lichens and allied fungi known from Ontario to 1069.

KEYWORDS. – Rare Species, biogeography, Appalachian-Great Lakes, Northeastern North America.

INTRODUCTION

Ontario is located in east-central Canada (Figure 1). It shares a border with Manitoba, Québec and six American states: Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin. Major water bodies occurring in the province include: Hudson Bay, Georgian Bay, Lake Ontario, Lake Erie, and Lake Superior. Ontario is Canada's second largest province (land area = 907,574 km^2) and the largest in population (12,160,282) (Statistics Canada 2007). It lies between 41° and 56° latitude and 49° and 45° longitude and its maximum elevation is 693 meters (Natural Resources Canada 2009). Five major forest regions cover the province: Carolinian, Great Lakes-St. Lawrence, boreal, boreal and tundra transition zone and the tundra along the Hudson Bay coast (Rowe 1972, Perera et al. 2000). Each zone contributes to the rich lichen biota of Ontario.

Lichens and allied fungi have been poorly studied in Canada overall (Goward et al. 1998). In Ontario, however, the lichen biota is better known than in many other provinces owing to considerable research by many lichenologists over the last 163 years (Tuckerman 1850, Billings 1862, Bell 1861, Macoun 1902, Faull 1913, Sjors 1961, Ahti 1964, Carleton and Maycock 1981, Carleton 1982, 1990, Nimis 1985, Kenkel 1986, 1987, Brumelis and Carleton 1989, Wong and Brodo 1973, 1990, 1992, Crowe 1994, Ahti and Crowe 1995, Matthes et al. 2000, Selva 2005, Brodo et al. *in prep.*, McMullin 2011, McMullin and Lewis *in prep*., McMullin and Lendemer *in press*, Lewis et al. *in prep*). Three areas in the province have been particularly well examined by lichenologists. The first is on the north shore of Lake Superior, where a rich lichen biota has regularly attracted lichen researchers (Crowe 1994, Ahti & Crowe 1995). The second is the Ottawa region; the extensive lichen collection at the Canadian Museum of Nature (CANL) has attracted lichenologists, many of whom have collected nearby during their visits. This, along with continuous investigation from local lichenologist Irwin Brodo, has resulted in the region around Ottawa being well examined and documented (Brodo 1988). The third is the Bruce Peninsula National Park and the Fathom Five National Marine Park, which was examined by a team of lichenologists during the 17th Tuckerman Workshop in 2008 (Brodo et al. *in prep.*). The first lichen checklist for the province included

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[1] RICHARD TROY MCMULLIN – Biodiversity Institute of Ontario Herbarium, Department of Integrative Biology, University of Guelph, Guelph, Ontario N1G 2W1, Canada. – e-mail: rmcmulli@uoguelph.ca

[2] CHRISTOPHER J. LEWIS – Ontario Ministry of Natural Resources, Species at Risk Branch, 300 Water St., 2nd Floor South, Peterborough, Ontario K9J 8M5, Canada. – e-mail: Chris.Lewis@ontario.ca

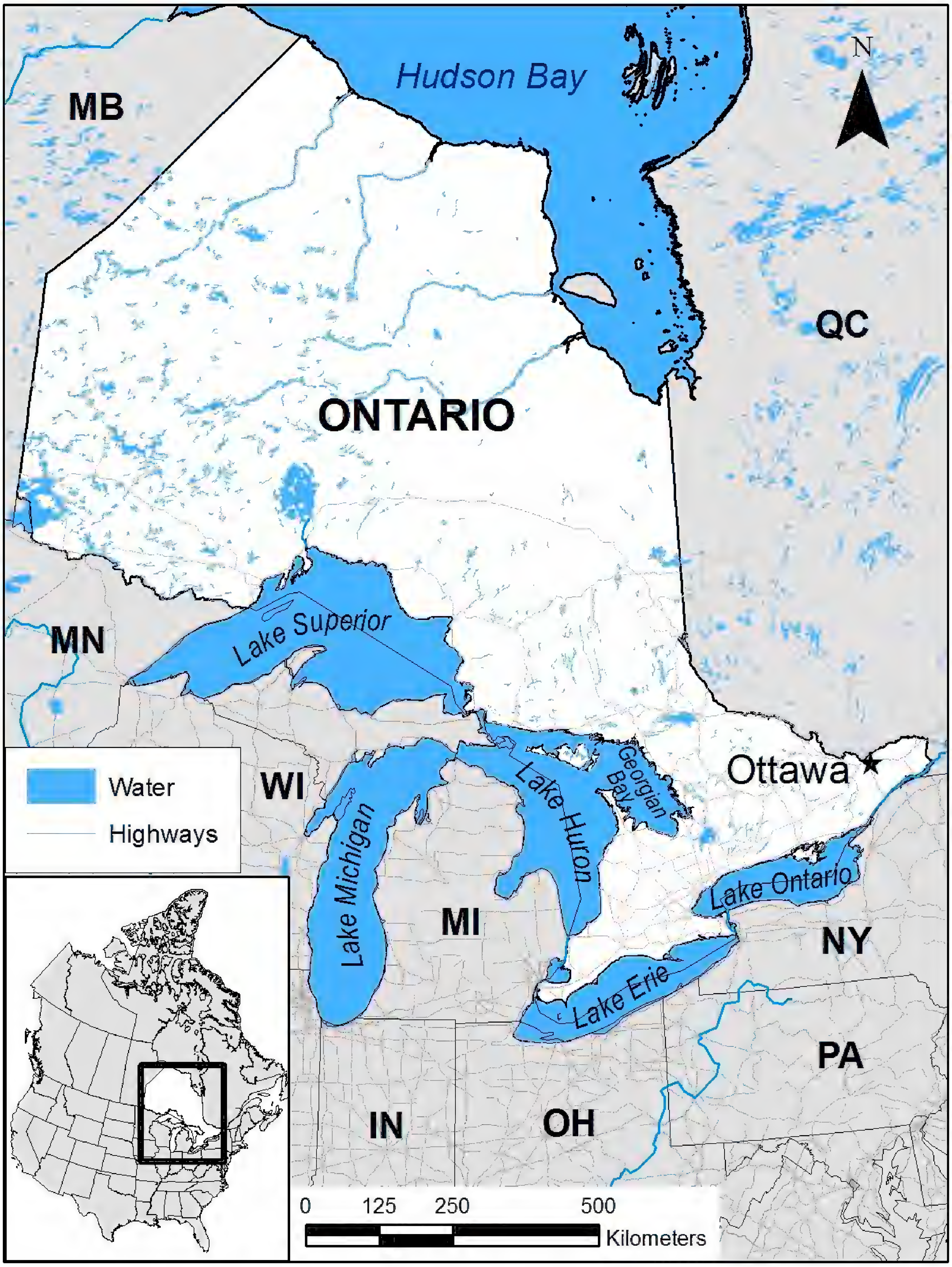

Figure 1. The Province of Ontario, including major water bodies and neighbouring provinces and states.

approximately 700 species (Newmaster et al. 1998). That initial list has since been expanded by the authors and other lichen researchers, the results of which have been or will soon be published (Selva 2005, Brodo et al. *in prep.*, McMullin 2011, McMullin et al. 2012, Lewis et al. *in prep*, McMullin and Lewis *in prep.*, McMullin and Lendemer *in press*). Here we report four species for the first time from Ontario and provide new records of 18 rare species. *Hyperphyscia syncolla* is also newly reported from Canada. Our additions to the current unpublished Ontario list, which has been compiled by the authors, bring the number of lichen species known in the province to 1069.

MATERIALS AND METHODS

Lichen specimens were identified with a compound or stereo microscope and chemical spot tests using para-phenylenediamine in ethyl alcohol, nitric acid, sodium hypochlorite, 10% potassium hydroxide, and Lugol's iodine (Brodo et al. 2001). Specimens that could not be reliably identified by morphology or spot tests were further studied using thin-layer chromatography following Culberson and Kristinsson (1970) and Orange et al. (2001). All specimens are deposited in the Canadian Museum of Nature (CANL) in Ottawa, Ontario, the Biodiversity Institute of Ontario (OAC) at the University of Guelph in Guelph, Ontario, and at the New York Botanical Garden (NY) in the Bronx, New York. The deposition of each specimen is listed after the authors' collection numbers in the annotated species list below.

NEW AND INTERESTING REPORTS

The species reported below are arranged alphabetically by genus and species. All records were examined by the authors. Non-lichenized fungi treated with lichens are preceded by a dagger "†". Species preceded by a star "*" are new to the Ontario lichen biota and the species preceded by two stars "**"is new to Canada. Nomenclature follows the 18th edition of the North American Lichen Checklist (Esslinger 2012). Authors are cited following Brummitt and Powell (1996).

Acrocordia cavata (Ach.) R.C. Harris

Acrocordia cavata was first reported from Ontario by Wong and Brodo (1990). One additional collection was made at the Bruce Peninsula National Park in 2008 during the 17th Tuckerman Workshop, *Harris 54881* (NY [n.v.]). Though this species appears to be uncommon in Ontario it has frequently been collected in Minnesota and may be more common in northwestern Ontario than collections suggest (CNALH 2013). *Anisomeridium polypori* (Willey) E. Lay & P. May is similar in appearance to *A. cavata* and is more common in Ontario, but the former has smooth ascospores biseriately or irregularly arranged in the ascus instead of the distinctly ornamented ascospores uniseriately arranged in the ascus of *A. cavata* (Harris 1977).

Specimens Examined. – **CANADA. ONTARIO.** PRINCE EDWARD CO.: Sandbanks Provincial Park, West Point, on a mature *Quercus rubra,* 06.iv.2012, *McMullin 11788* (OAC); Sandbanks Provincial Park, Outlet Campground, mature mixed-wood forest, on *Populus*, 06.iv.2012, *McMullin 9035* (OAC), *McMullin 11791* (OAC); Sandbanks Provincial Park, Dunes Beach, mature mixed-wood forest, on a mature *Populus*, 08.x.2012, *McMullin 11791* (OAC).

Bacidina egenula (Nyl.) Vězda

Here we present the third report of *Bacidina egenula* from Ontario. It was first reported from the Ottawa region by Ekman (1996) and later found in 2008 during the 17th Tuckerman Workshop on the Bruce Peninsula (Brodo et al. *in prep.*). More recently, the collection cited below was made in Guelph. *Bacidina egenuloidea* (Fink) S. Ekman is similar in appearance, but lacks the green color found in the hymenium of *B. egenula* (Ekman 1996).

Specimen Examined. – **CANADA. ONTARIO.** WELLINGTON CO.: Guelph, University of Guelph, The Arboretum, in the Japanese Garden, 21.v.2010, on calcareous rock with partial shade, *McMullin 7101* (OAC).

**Bryoria fremontii* (Tuck.) Brodo & D. Hawksw.

This is the first report of this species for Ontario. In western North America it is common from California to British Columbia (Brodo & Hawksworth 1977). Previously, the eastern extent of its known range was a disjunct population in Churchill, Manitoba (Brodo & Hawksworth 1977, Brodo et al. 2001). The first collection from Ontario was made in the Lake Abitibi region in the northeast. The range within the province was expanded when molecular analyses of woodland caribou (*Rangifer tarandus caribou*) scat revealed that the animals were selectively foraging on *Bryoria fremontii* in winter months in the northwest as well (McMullin et al. *in prep.*). The lack of lichen substances and distinctly twisted primary branches are distinctive characteristics among *Bryoria* species in Ontario (Brodo & Hawksworth 1977).

Specimen Examined. – **CANADA. ONTARIO.** COCHRANE DISTRICT: Steele Township, Iroquois Falls Forest North, mature conifer forest, 06.viii.2008, on *Picea mariana* branches, *McMullin 7581* (OAC).

Candelaria fibrosa (Fr.) Müll. Arg.

This is the first Ontario record for *Candelaria fibrosa* in more than a century (Wong & Brodo 1992). It is typical of southeastern North America and its northern limit reaches into southern Ontario and northern American states such as Minnesota, Wisconsin, and Michigan (Brodo et al 2001). Previous collections were made by John Macoun (*5, 236, 286, 560, 559*; all at CANL [n.v.]) and George Lawson (s.n., CANL [n.v.]) around the turn of the 19th century from south-eastern Ontario. Due to the paucity of records, Brodo et al. (2001) speculated that this species was extirpated from Canada. This new record, however, confirms that the species remains, for the time being, a part of the Canadian lichen biota. The more common *C. concolor* (Dicks.) Stein is distinguished by the presence of soredia.

Specimen Examined. – **CANADA. ONTARIO.** BRUCE CO.: Sauble Beach, Sauble Falls Rd., 10.vi.2009, on large *Populus* trunks, *Lewis 325* (CANL).

†*Chaenothecopsis exilis* Tibell

This is the second Ontario report of this species. It was first reported from the type collection made in Pic Township in the Black River Gorge, east of Heron Bay (*Tibell 5389*, UPS [n.v.]) (Selva & Tibell 1999). *Chaenothecopsis debilis* is similar in appearance, but has a brown to green instead of hyaline hymenium and its ascospores are larger (6.8-9.0 x 2.4-3.2 µm vs. 6.4-8.0 x 2.4-2.9 µm *fide* Selva & Tibell (1999)).

Specimens Examined. – **CANADA. ONTARIO.** SIMCOE CO.: Copeland Forest, mature mixed-wood forest, 16.ix.2011, lignicolous on a snag, *McMullin 8071* (OAC), 03.x.2011, lignicolous on a snag, *McMullin 8068* (OAC). COCHRANE DISTRICT: Heighington Township, Iroquois Falls Forest North, mature mixed-wood stand that was conifer dominated, 20.vii.2008, lignicolous on a snag, *McMullin 10128* (OAC). KENORA DISTRICT: English River Forest, young conifer stand, 02.viii.2009, lignicolous on a snag, *McMullin 10128* (OAC). NIPISSING DISTRICT: Algonquin Provincial Park, Carl Wilson Lake, mixed-wood forest, 31.vii.2011, lignicolous on a snag, *McMullin 7886* (OAC). WELLINGTON CO.: Guelph, University of Guelph, The Arboretum, mixed-wood forest, 21.vii.2011, lignicolous on a snag, [collected by Jose Maloles] *McMullin 7886* (OAC).

†*Chaenothecopsis haematopus* Tibell

This is the second Ontario report of *Chaenothecopsis haematopus*. The first report was from Simpson Island near the north shore of Lake Superior in 1972 (*Tibell 5384*, UPS [n.v.]) (Selva & Tibell 1999). This species also appears to be rare in Canada. It was previously known from one collection in British Columbia (Selva & Tibell 1999) and two collections in Nova Scotia (McMullin et al. 2008). Among the species known from Ontario, its red stalks that turn green in KOH make this species distinctive among the calicioids.

Specimen Examined. – **CANADA. ONTARIO.** COCHRANE DISTRICT: Gorden Cosen's Forest Management Unit, conifer dominated forest, 13.viii.2008, on a decorticated snag, *McMullin 11771* (OAC).

Collema limosum (Ach.) Ach.

This is the most recent record of an inconspicuous species that is widespread in Ontario, but rarely collected and perhaps uncommon in the province. *Collema limosum* is a soil dwelling species that is often found in exposed, humid habitats, especially those in close proximity to water, growing on calcareous clay or sandy soils (Hinds & Hinds 2007). It is inconspicuous and often overlooked, which may be the reason for its perceived rarity. It is tolerant of soil disturbance and capable of growing in urban settings (Björk & Goward 2010). Its characteristic traits include 4-spored asci, large apothecia (<2 mm in diameter) and a poorly developed membrane-like thallus that lacks distinct lobes.

Specimen Examined. – **CANADA. ONTARIO.** GREY CO.: Inglis Falls Conservation Area, south of Owen Sound, on the banks of the Sydenham River, 25.ix.2010, on calcareous sandy soil, *Lewis 489* (CANL)

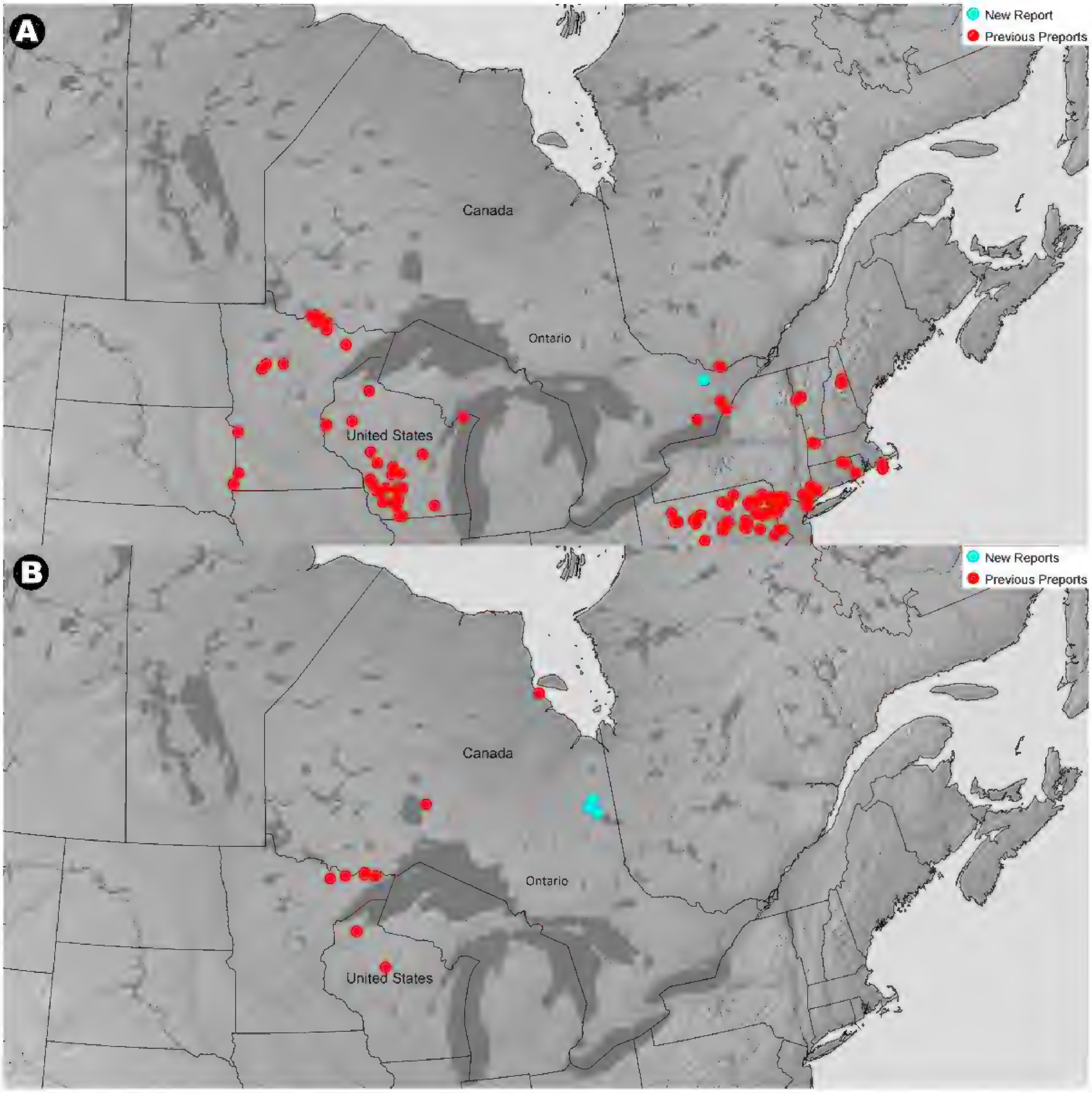

Figure 2. A, distribution of *Flavoparmelia baltimorensis* in and near Ontario, locations determined from all available data on the Consortium of North American Lichen Herbaria (CNALH 2013). B, distribution of *Heterodermia galactophylla* in and near Ontario, locations determined from all available data on the Consortium of North American Lichen Herbaria (CNALH 2013).

Evernia prunastri (L.) Ach.

This is the third modern report of this species from Ontario. The first recent collection was made in the Thunder Bay area in 1974, *Barclay 9439* (F [n.v.]). The next collection was made during the 17th Tuckerman Workshop in 2008 on the Bruce Peninsula (Brodo et al. *in prep.*). *Evernia prunastri* was once thought extirpated from southern Ontario as it had not been collected in more than a century (Wong & Brodo 1992). It is typically a bicoastal species occurring in North America (Brodo et al. 2001). In Ontario, it can be distinguished from the much more common *E. mesomorpha* Nyl. by flatter dorsiventral branches that are whitish below and pale green above.

Specimen Examined. – **CANADA. ONTARIO.** WELLINGTON CO.: Guelph, University of Guelph, The Arboretum, by the main entrance along College Street, 08.iv.2011, on a utility (telephone) pole, *McMullin 9604* (OAC).

Flavoparmelia baltimorensis (Gyeln. & Fóriss) Hale

Flavoparmelia baltimorensis is widespread in North America, but is most common in the south. The northern limit reaches into southern Québec and southern Ontario along with northern United States such as Minnesota, Wisconsin and Vermont (Brodo et al 2001). In Ontario, it has previously been collected six times, but in neighboring states it is commonly reported (Figure 2A). The collection reported here is from the same area as a historical collection in the province (Wong 4053, CANL [n.v.]) and confirms its continued presence in the area. Pustular isidia distinguish *F. baltimorensis* from the more common *F. caperata* (L.) Hale.

Specimens Examined. – **CANADA. ONTARIO.** RENFREW CO.: Calabogie, Ontario on the NE side of Calabogie Peaks Resort Mountain, 12.iv.2011, on a moist cliff face, *Lewis 591* (CANL), *Lewis 592* (NY).

**Fulgensia bracteata* (Hoffm.) Räsänen ssp. *bracteata*

These are the first reports of this species and genus from Ontario. It is typically a prairie species and our records represent the eastern extent of its known range (Brodo et al. 2001, CNALH 2013). Both specimens were collected in the same area and habitat on Manitoulin Island. In Ontario, it is distinguished from superficially similar species of *Caloplaca* by its simple ascospores.

Specimens Examined. – **CANADA. ONTARIO.** MANITOULIN DISTRICT: Robinson Township, Manitoulin Island, Misery Bay, on a limestone alvar, vii.2005, growing over *Tortella rigens*, [collected by Nancy Ironside] *McMullin 9440* (CANL), 19.vi.1997, growing over *Tortella inclinata, Schaefer 1812* (CANL).

Heterodermia galactophylla (Tuck.) Culb.

There are few collections of *Heterodermia galactophylla* in Ontario. Two previous collections were made in the province and five are reported from Minnesota along the Ontario border, which suggests it is likely more common in northwestern Ontario than the available collections indicate (Figure 2B). All of the specimens reported here were on mature deciduous trees in conifer dominated forests on sandy soils in northeastern Ontario. This species is distinguished by labriform soralia, which are strongly reflexed and wider than the rest of the lobe, as well as the presence of terpenoids (Lendemer 2009).

Specimens Examined. – **CANADA. ONTARIO.** COCHRANE DISTRICT: Freele Township, Iroquois Falls Forest, mature mixed-wood conifer dominated forest, 14.vii.2008, on a mature *Populus*, *McMullin 10031* (OAC); Heighington Township, Iroquois Falls Forest North, mature mixed-wood conifer dominated forest, 20.vii.2008, on a mature *Populus*, *McMullin 10136* (OAC), 19.viii.2010, *McMullin 8174* (OAC); Tweed Township, Iroquois Falls Forest North, mature mixed-wood conifer dominated forest, 24.vii.2008, on a mature *Populus*, *McMullin 10342* (OAC); Tweed Township, Iroquois Falls Forest North, mature mixed-wood conifer dominated stand, 04.viii.2008, on a mature *Populus*, *McMullin 10615* (OAC).

***Hyperphyscia syncolla* (Tuck. *ex* Nyl.) Kalb

These are the first Ontario and Canadian records for *Hyperphyscia syncolla*, where it is currently known only from Sandbanks Provincial Park. It occurs throughout the central and eastern continental United States and previously was thought to reach its northern limit close to the Canada border (Brodo et al. 2001). This tightly appressed species lacks rhizines, often appears crustose, and resembles species of *Rinodina*. However, the margins are distinctly foliose when closely examined. Similar species of *Phaeophyscia* are thicker, possess rhizines, and are not as closely appressed, and similar species of *Physcia* have atranorin in the cortex (KOH + yellow).

Specimens Examined. – **CANADA. ONTARIO.** PRINCE EDWARD CO.: Sandbanks Provincial Park, Group Camping, mature mixed-wood forest, 06.iv.2012, on a mature *Populus*, *McMullin 9194* (OAC); Sandbanks Provincial Park, Dunes Beach, mature mixed-wood forest, 10.v.2012, on a mature *Populus*, *Lewis 1102* (CANL); Sandbanks Provincial Park, West Point, mature mixed-wood forest, 06.iv.2012, on a mature *Quercus rubra*, *McMullin 9184* (OAC).

**Hypogymnia incurvoides* Rass.

These are the first reports of *Hypogymnia incurvoides* from Ontario, which represent the western extent of its known range in North America. When McCune et al. (2006) reported *H. incurvoides* from North America for the first time they based the report on vouchers from eastern Canada. In the past, the species was included within the concept of the more common *H. physodes* (L.) Nyl. That species is similar in appearance, but has a KOH+ red-brown medulla (due to the presence of 3-hydroxyphysodic acid; vs. KOH- in *H. physodes*), the lobe tips are not as commonly perforated, the lobe margins are not as black, and it lacks the lattice-like growth pattern that is typical of *H. incurvoides* (McCune et al. 2006).

Specimens Examined. – **CANADA. ONTARIO.** SUDBURY DISTRICT: Chapleau, conifer forest, 28.viii.2009, growing on *Abies* bark, *Lewis 344* (CANL); Biscotasi Lake, a steep slope along the shoreline, 23.ix.2008, growing on conifer branches along the shore, *Lewis 154* (CANL). NIPISSING DISTRICT: Algonquin Provincial Park, south end of Carl Wilson Lake, mature deciduous forest, 11.vii.2011, on a snag, *McMullin 7868* (OAC); Algonquin Provincial Park, High Falls Trail area, mature deciduous forest surrounding a moist shaded cedar forest beside the York River, 30.iii.2010, on *Thuja occidentalis*, *Lewis 365* (CANL); Algonquin Provincial Park, Hemlock Bluffs Trail area, mature deciduous forest with ravines and low-lying areas, 30.i.2010, on spruce twig, *Lewis 351* (CANL); Matabitchuan River, talus slope along the shoreline, 28.vi.2008, on conifer branches along the shore, *Lewis 168* (CANL). COCHRANE DISTRICT: Stimson Township, Iroquois Fall Forest, mature conifer stand, 08.vii.2011, on *Picea mariana*, *McMullin 9924* (OAC).

Leptogium hirsutum Sierk

This appears to be the first record of *Leptogium hirsutum* from Ontario in more than a century. Material referable to this taxon was last collected in the province by John Macoun in the late 1800's (Macoun 1902, revised by Wong & Brodo 1992). Three specimens from the Slate Islands of Lake Superior, collected in 1977 and determined by Clifford Wetmore as *L. burnetiae* C.W. Dodge, are deposited at MIN (*Wetmore 28346, 29532, 29142*, all in MIN [n.v.]). The descriptions of *L. hirsutum* and *L. burnetiae*, described in the same year (Sierk 1964, Dodge 1964), are similar and variation within the way the species have been delineated appears to have resulted in poor taxonomic resolution. The authors have not examined material on deposit at MIN and do not know which name should be applied to these specimens. Harris and Ladd (2005) distinguish *L. hirsutum* by its granular isidia instead of the cylindrical and often branching isidia of *L. burnetiae*. Using their descriptions, all of the specimens reported here are *L. hirsutum*.

Specimens Examined. – **CANADA. ONTARIO.** COCHRANE DISTRICT: Heighington Township, Iroquois Falls Forest North, mature mixed-wood conifer dominated stand , 20.vii.2008, on a mature *Populus*, growing near *Heterodermia galactophylla*, *McMullin 10141* (OAC); Block 55549, Iroquois Falls Forest North, mature mixed-wood conifer dominated stand, 09.viii.2008, on a large *Populus balsamifera* snag, *McMullin 10800* (OAC).

Megaspora verrucosa (Ach.) Hafellner & V. Wirth

Megaspora verrucosa has not been collected in southern Ontario since before the 1930's (Wong & Brodo 1992). It is typically an arctic-alpine species growing on peat, vegetation, and wood, especially *Populus* (Thomson 1997). The species is known from four collections from the Hudson Bay and James Bay coasts and the north shore of Lake Superior (Thomson 1997, Brodo et al. 2010, CNALH 2013). In Minnesota, it has been abundantly collected near the Ontario border, which suggests that it may be more common in northwestern Ontario than collections indicate (CNALH 2013). In southern Ontario, it appears to be restricted to remnant mature hardwood forests, which may reflect a wider distribution in the past that was reduced by disturbance to the forest ecosystems it requires.

Specimens Examined. – **CANADA. ONTARIO.** GREY CO.: Eugenia Falls Conservation Area in the Hamlet of Eugenia, on the shore the Beaver River, 26.ix.2010, on a mature *Acer saccharum* trunk in the parking lot, *Lewis 479* (CANL). RENFREW CO.: Calabogie, on the northeast side of Calabogie Peaks Resort Mountain, 12.ii.2010, on an old *Acer saccharum* trunk, *Lewis 356* (CANL);17 km south of White Lake, 24.x.2004, on *Acer saccharum*, *Brodo 31707* (CANL).

Microcalicium disseminatum (Ach.) Vain.

Within Ontario, *Microcalicium disseminatum* is known from one collection on the north shore of Lake Superior (Crowe 1994) and one collection from Darling Long Lake in the southeast (Selva 2005). It also appears to be uncommon in neighboring provinces and states (Figure 4). This species is distinguished from other calicioid species by its sessile ascomata and cylindrical ascospores that are usually more than 2-celled (Tibell 1999).

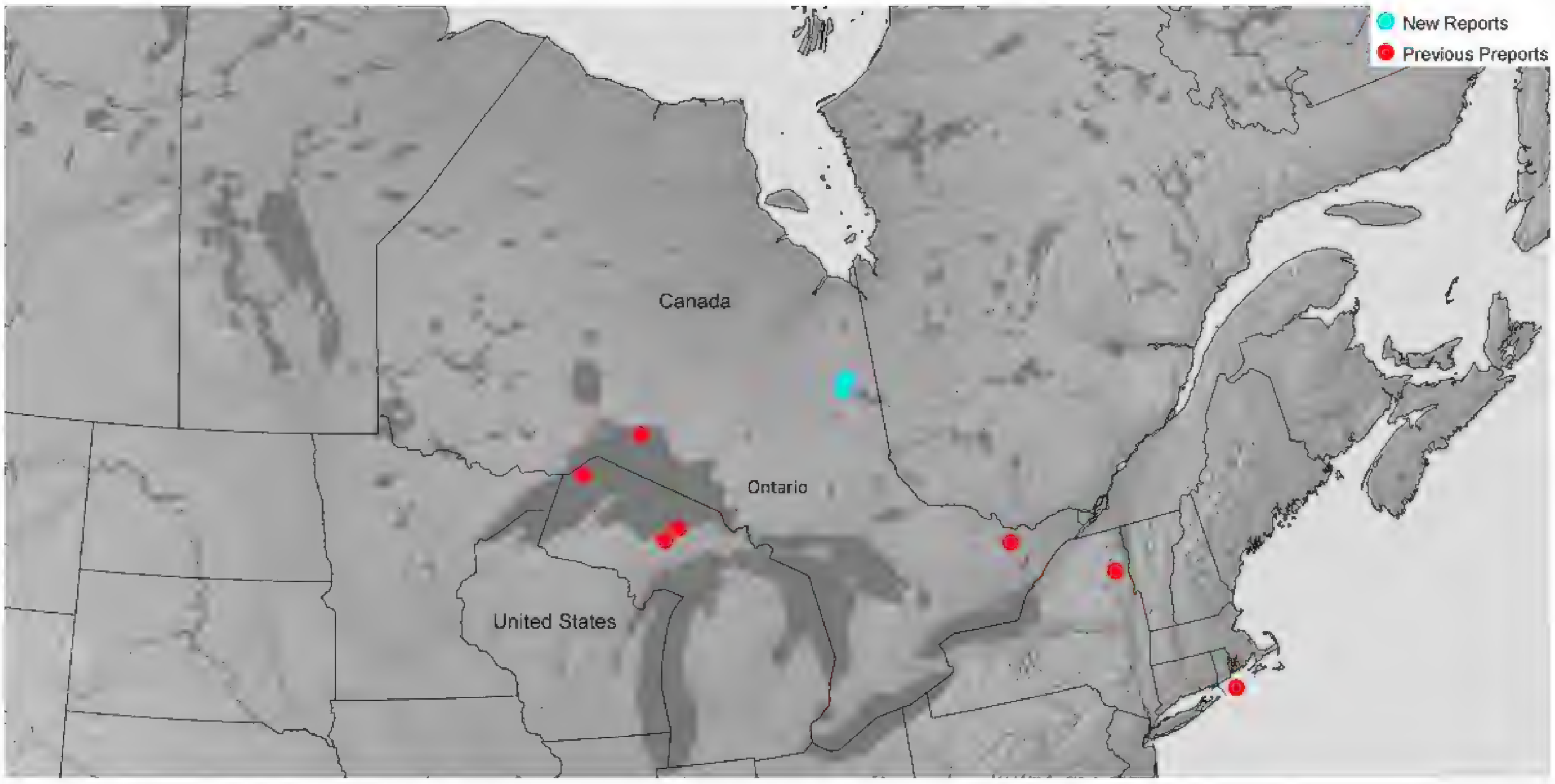

Figure 3. Distribution of *Microcalicium disseminatum* in and near Ontario, locations determined from all available data on the Consortium of North American Lichen Herbaria (CNALH 2013).

Specimens Examined. – **CANADA. ONTARIO.** COCHRANE DISTRICT: Raven Township, Iroquois Falls Forest, old conifer forest, 14.vii.2008, on *Picea mariana*, *McMullin 10000* (OAC). Stimson Township, Iroquois Falls Forest, old open canopy conifer forest, 11.vii.2008, on *Picea mariana*, *McMullin 9929* (OAC).

Myelochroa obsessa (Ach.) Elix & Hale

Myelochroa obsessa reaches its northern limit in southern Ontario and several northern American states, including Minnesota, Wisconsin and New York (Brodo et al. 2001). It is abundantly reported in Minnesota along the Ontario border (CNALH 2013), therefore it is likely more common in northwestern Ontario than is currently known. Other species of *Myelochroa* in Ontario lack isidia. The more common *Imshaugia aleurites* (Ach.) S.L.F. Meyer is a similar species in the province, but it has a pale lower surface instead of black.

Specimen Examined. – **CANADA. ONTARIO.** RENFREW CO.: Calabogie, on the northeast side of Calabogie Peaks Resort Mountain, 12.iv.2011, on granitic rock, *Lewis 594* (CANL).

Psorotichia schaereri (A. Massal.)

This is the second report of *Psorotichia schaereri* from Ontario and the third for Canada. The first provincial report was from the Bruce Peninsula in 2008 during the 17th Tuckerman Workshop (Brodo et al. *in prep.*). It is a small cyanolichen found on calcareous rocks or walls (Jørgensen 2007).

Specimen Examined. – **CANADA. ONTARIO.** GREY CO.: Inglis Falls Conservation Area, south of Owen Sound, on the banks of the Sydenham River, 23.ix.2009, on top of moist limestone boulders in the river, *Lewis 347* (CANL).

Punctelia appalachensis (W. L. Culb.) Krog

Hale (1979) provided a distribution map for *Punctelia appalachensis* that includes parts of Ontario. There appears, however, to be no known specimens in herbaria or in published literature from Ontario. There are seven known collections of *P. appalachensis* in Canada (including the one reported here from Ontario). The other locations for this species are in New Brunswick (*Gowan 2616*, CANL [n.v.]) and Nova Scotia (*Brodo 31443* CANL [n.v.], *Egan 16273* OMA [n.v.], *Egan 16341* ASU and OMA [n.v.], *Lewis 464* CANL, and *McMullin 11765* OAC). It is mainly distributed in the Appalachian Mountains with disjunct populations in Minnesota (Brodo et al. 2001). This corticolous species is foliose with a blue-gray to green thallus that is esorediate, with abundant lobules, a white medulla that is C-, and a black lower cortex with +/- brown margins (Hinds & Hinds 2007).

Specimens Examined. – **CANADA. ONTARIO.** GREY CO.: Kinghurst Forest Reserve, northeast of Hanover, 200-300 year old *Acer-Fagus* forest, 2.iv.2011, on fallen *Acer saccharum* trunk, *Lewis 578a* (CANL), *Lewis 578b* (NY), *Lewis 578c* (OAC).

Rinodina pachysperma H. Magn.

Rinodina pachysperma is known from few collections in Ontario. The first reports were made by John Macoun in the Ottawa area in 1895 (*Macoun 357* CANL [n.v.]) and in Hastings County in 1869 (*Macoun 1889* and *1890*, both in CANL [n.v.]). More recently, it was collected in the Ottawa area, but on the Québec side of the border, by John Sheard (Sheard 2010) and by James Lendemer in 2011 (*Lendemer 28384*, NY [n.v.]). Several collections were also made in Minnesota by Clifford Wetmore along the Ontario border so it likely occurs in northwestern Ontario as well (CNALH 2013). *Rinodina pachysperma* is a corticolous species possessing *Pachysporaria*-type II ascospores and lacks vegetative propagules (Sheard 2010).

Specimen Examined. – **CANADA. ONTARIO.** RENFREW CO.: Calabogie, on the northeastern side of Calabogie Peaks Resort Mountain, 12.ii.2011, on a *Fagus grandifolia* trunk, *Lewis 359* (CANL).

Teloschistes chrysophthalmus (L.) Th. Fr.

John Macoun first reported *Teloschistes chrysophthalmus* from Ontario from the Bellville area and Point Pelee National Park in the late 1800's, but it has not been reported from the province since (Wong & Brodo 1992). It is has commonly been collected in Minnesota and there are some records from southern Manitoba, which suggests it may occur in the southwestern corner of northwestern Ontario (CNALH 2013). Roman Olszewski alerted the authors to the presence of the specimen reported here after his unpublished 1996 inventory of the lichens of Sandbanks Provincial Park. Five poorly developed thalli remain on two trees in the park. Photographs of these specimens have been deposited in OAC. One additional specimen from Sandbanks collected in 1995 is in a private herbarium (*Olszewski 3680* [n.v.]). *Teloschistes chrysophthalmus* is sensitive to air pollution, which is thought to be the reason for its decline in Ontario and New England (Wong & Brodo 1992, Hinds & Hinds 2007).

Specimen Examined. – **CANADA. ONTARIO.** PRINCE EDWARD CO.: Sandbanks Provincial Park, West Point, 06.iv.2012, on a mature *Quercus rubra, McMullin 9100* (OAC).

Trypethelium virens Tuck.

Trypethelium virens is common and widespread in eastern North America south of the Canadian border (Brodo et al. 2001). Previous collections known from Ontario were made by John Macoun in the late 1800's in the southeast (Wong & Brodo 1992), R.F. Cain in 1955 in Parry Sound (*Cain 26671*, WIS [n.v.]), and by Henry Imshaug in 1960 in the Blue Mountains (*Imshaug 26992*, MSC [n.v.]). *Trypethelium virens* is the only member of this large tropical genus in Canada. In Ontario, it is typically found in old undisturbed forests, which are now limited in the province. Much of the material cited below is lacking ascospores.

Specimens Examined. – **CANADA. ONTARIO.** BRUCE CO.: northwest of Hanover, mature *Acer-Fagus* forest, 16.vi.2012, on *Fagus grandifolia* trunk, *Lewis 1168* (CANL) south of Mildmay, Saugeen Valley Conservation Authority managed forest, mixed forest, 16.vi.2012, on *Fagus grandifolia* trunk, *Lewis 1169* (CANL). GREY CO.: Kinghurst Forest Reserve, northeast of Hanover, mature *Acer-Fagus* forest 200-300 years old, 14.iv.2012, on *Fagus grandifolia* trunk, *Lewis 1030* (CANL). HASTINGS CO.: north of Madoc, Ontario, Elsvier Twp., 6.v.2011, on old *Fagus grandifolia* trunk, *Lewis 606* (CANL). PETERBOROUGH CO.: Quackenbush Provincial Park, mature forest, 3.iii,2012, on large *Fagus grandifolia* trees, *Lewis 955* (CANL). PRINCE EDWARD CO.: Sandbanks Provincial Park, 20.iii.2011, on large *Fagus grandifolia* trees along road side, *Lewis 526* (CANL). RENFREW CO.: Calabogie, Ontario on the NE side of Calabogie Peaks Resort Mountain, 12.iv.2011, on *Fagus grandifolia* trunk*, Lewis 590* (CANL); North Canonto Twp., Arcol Road, 23.iii.2012, on *Fagus grandifolia* trunk*, Lewis 981* (CANL).

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Cladonia appalachensis, belated description of a southern Appalachian lichen endemic from the Great Smoky Mountains

JAMES C. LENDEMER[1] & RICHARD C. HARRIS[2]

ABSTRACT. – *Cladonia appalachensis*, a species recognized nearly half a century ago, is formally described as new to science. The taxon is hypothesized to be narrowly endemic to high elevations of the southern Appalachian Mountains where it is closely associated with outcrops of the metal-rich Anakeesta Formation. The species produces squamatic acid and is most similar to the Amazonian *C. peltastica*.

KEYWORDS. – Great Smoky Mountains, biodiversity, biogeography, spruce-fir forest.

INTRODUCTION

The southern Appalachian Mountains of eastern North America have long been recognized as a biodiversity hotspot for many groups of organisms (Wuerthner 2003), including lichens (Hodkinson 2010, Lendemer & Tripp 2008). Recent work in the Great Smoky Mountains has significantly expanded our knowledge of the latter, documenting the occurrence of more lichen species than any other National Park in North America (Lendemer et al. 2013, Tripp & Lendemer 2012). Despite the fact that more than eight hundred species have been reported from the Smokies, continued inventory efforts by the authors have led to many additional discoveries. These have included numerous new reports of species, modern reports of species known only from historical collections, and the recognition of species new science (Lendemer et al. 2013, Lendemer & Harris 2013, Sheard et al. 2012).

Among the unresolved taxa encountered during our continued fieldwork was an unusual population of the macrolichen genus *Cladonia* that was found growing on the shaded face of a massive rock outcrop at a high elevation (Figure 1). Subsequent study led to the discovery that the same species had been collected nearly half a century before by Aaron J. Sharp on a similar rock outcrop elsewhere in the Smokies. The species was so different from all others known at the time that Sharp and his Japanese colleague Isao Yoshimura recognized it as a new species with the manuscript name *C. "appalachensis*". In revising members of the genus *Cladonia*, Teuvo Ahti also encountered a specimen of the same species collected in the Smokies by Rudolf Becking that was sent to one of us (RCH) in the early 1970's for identification but set aside as a problem requiring further study. Ahti recognized it as distinct and gave it the manuscript name *C. "subpeltastica"*. Unfortunately, despite being known for nearly half a century, the species in question has never been described. Here we formally describe this taxon, validating the name originally bestowed by Sharp and Yoshimura, and recognize it as a narrow endemic of Anakeesta Formation outcrops in the Smokies.

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[1] JAMES C. LENDEMER – Institute of Systematic Botany, The New York Botanical Garden, Bronx, NY 10458-5126. – e-mail: jlendemer@nybg.org
[2] RICHARD C. HARRIS – Institute of Systematic Botany, The New York Botanical Garden, Bronx, NY 10458-5126. – e-mail: rharris@nybg.org

MATERIALS AND METHODS

This study is based on specimens deposited in the herbarium of the New York Botanical Garden (NY). Chemical and morphological investigations were carried out using the methods outlined in detail by Lendemer and Harris (2013) and descriptive terminology largely follows Ahti and Sipman (2013). Due to the extremely rare and endemic nature of this species, the National Park Service has requested that the exact localities not be published. Workers wishing to conduct further studies on this species are requested to contact the authors, or the Research Coordinator at Great Smoky Mountains National Park.

TAXONOMIC SECTION

***Cladonia appalachensis* Yoshim. & Sharp *ex* Lendemer & R.C. Harris sp. nov.**
Mycobank #805188.

TYPE: U.S.A. TENNESSEE. SEVIER CO.: Great Smoky Mountains National Park, vicinity of Charlies Bunion, 1670 m, wet, shaded, seepy N-facing slope of massive Anakeesta rock outcrop with ericaceous heath, 19.x.2012, on rock, *J.C. Lendemer 33320 & A. Moroz* (NY!, holotype; H!, isotype).

DIAGNOSIS. – Similar to *Cladonia peltastica* but differing in its occurrence on rock outcrops in the southern Appalachian Mountains and the absence of usnic acid.

DESCRIPTION. – Primary thallus evanescent, not observed in the material available. Podetia erect but often somewhat bent and densely tangled (Figure 2A), 2-3 cm tall, 0.4-0.8 mm thick, with irregular anisotomous dichotomous branching, of indeterminate growth, distinctly whitish grey but often with a brownish hue when viewed from a distance; basal portions typically darkening from brown to black in the extreme lower portions (Figure 2C); forming cushion-like clusters of thalli that merge into a congested mat (Figures 1B and 2A); axils closed; tips often curved or bent, acuminate (Figure 2B). Podetial surface dull, emaculate, weakly pruinose in the upper portions, without soredia, appearing continuously corticate but actually with a surface comprised of closely aggregated patches of cortex separated by a network of thin exposures of the medulla (upper portions) or stereome (lower portions); cortex patchy, patches smooth and indistinctly separated in the upper portions of the podetia, becoming verruculose and distinctly separated in the lower portions. Podetial wall ~0.1 mm thick, comprised of anticlinal prosoplectenchymatous hyphae, not distinguished from the stereome; central cavity narrow, glabrous, smooth to weakly striate. Pycnidia brown, borne apically on the tips of the podetia, mature pycnidia with conidia not observed, slime color unknown.

CHEMISTRY. – Squamatic acid. Spot tests: K-, C-, KC-, P-, UV+ blue-white.

ECOLOGY AND DISTRIBUTION. – The new species is known from several populations in Great Smoky Mountains National Park in the southern Appalachian Mountains of eastern North America (Figure 2D). These populations occur at high elevation (>1524 m) sites in the spruce-fir forest zone and are specifically associated with cool, protected faces of massive exposed outcrops of the Anakeesta Formation (Figure 1). The Anakeesta Formation comprises rocks of Precambrian age that are characterized by iron-sulfide rich slate, shale, and sandstones that weather to a distinctive reddish-brown color (Moore 1988). For a detailed discussion of this, and other, geological formations in the Great Smoky Mountains the reader should refer to Southworth et al. (2012).

Large outcrops of the Anakeesta Formation are restricted to a relatively small area of the southern Appalachian Mountains and are known to host a unique community of lichens including endemic, near-endemic, and disjunct species (Lendemer & Harris 2013). The unique lichen communities associated with the Anakeesta Formation are likely a result of the unusual chemistry of the rocks coupled with their exposure in physiographically isolated, high elevation sites. We hypothesize that *Cladonia appalachensis* belongs to this community and represents a narrow endemic restricted to outcrops of the Anakeesta Formation.

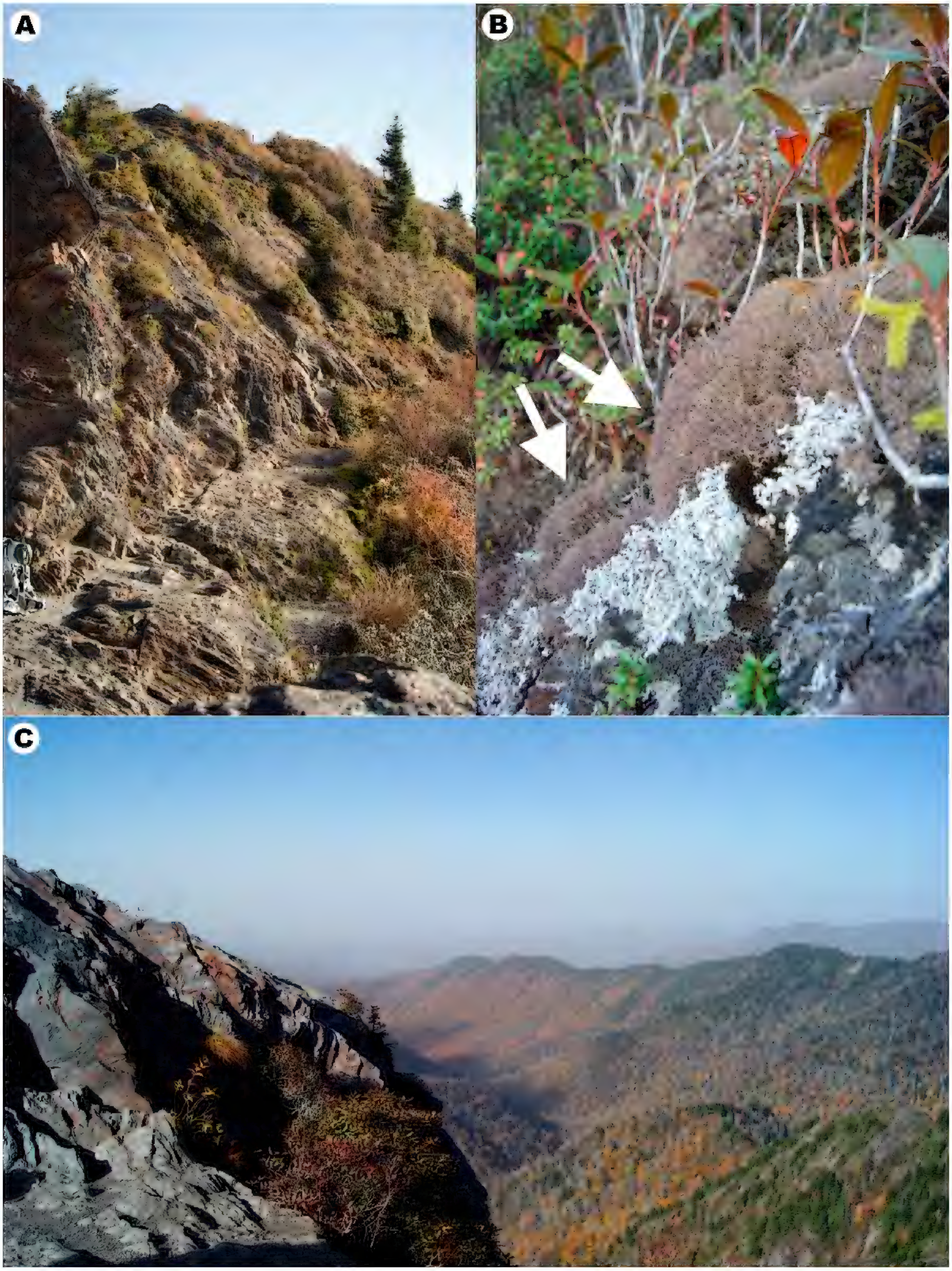

Figure 1. Type locality and habit of *Cladonia appalachensis*. A, exposed heath bald at the type locality. B, habit of *C. appalachensis* illustrating the cushion-like colonies (arrows) that can merge to form a congested mat (upper colony). C, westward view of the Great Smoky Mountains from Charlie's Bunion (rock outcrop on left) in autumn.

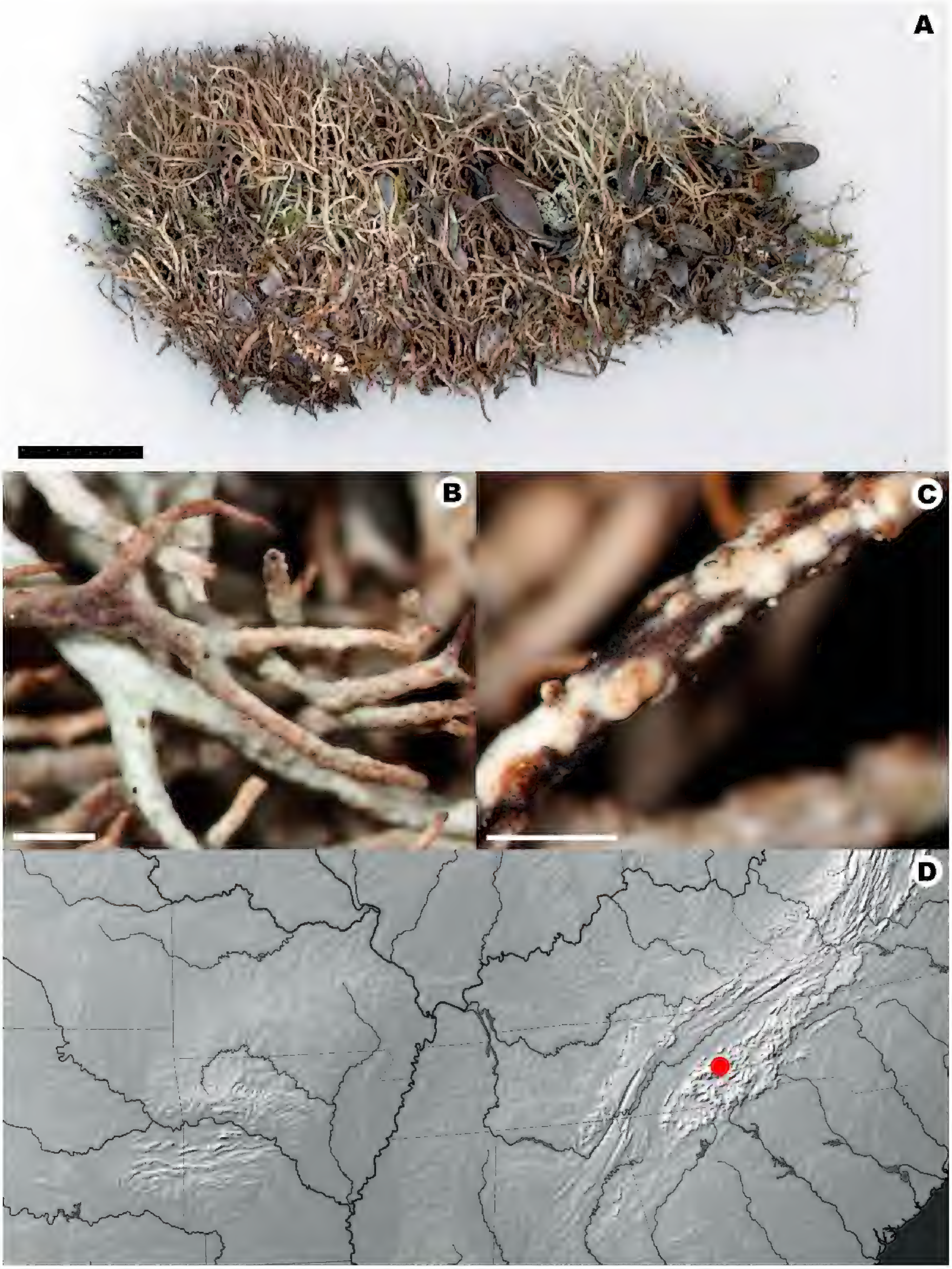

Figure 2. Morphology (A-C, all from the holotype) and known geographic distribution (D) of *Cladonia appalachensis*. A, thallus and podetial morphology illustrated via a flatbed scanner (scale = 1.0 cm). B, upper portion of podetium illustrating branching pattern, apical pycnidia, and dispersed cortex (scale = 0.5 mm). C, basal portion of podetium illustrating darkening of the stereome (scale = 0.5 mm). D, known distribution of *C. appalachensis* plotted on a topographic map illustrating the positions of the Atlantic Coast (right), Appalachian Mountains (center right), and Ozark-Ouachita Regions (left).

CONSERVATION STATUS. – When we initially prepared the description of the species we were unaware of any collections made by Jonathan Dey at high elevations during more than three decades of extensive fieldwork in the southern Appalachians. Subsequently we located three collections of *C. appalachensis* made by Dey during his thesis related fieldwork in the 1970's. These were from the type locality, and within the vicinity of the summit of Mt. LeConte. All three collections had been left undetermined since the 1970's.

Considering its size and distinctive appearance it is highly unlikely that *Cladonia appalachensis* has been overlooked by collectors. Thus it is not probable that it is more widespread than the available material indicates. As far as we are aware, all lichenologists who have seen material of the species in the past have been so struck by it that they gave it a manuscript name, considering it new to science, or left it undetermined recognizing the need for further study. The belated formal description of the taxon is, nonetheless, timely in the broader context of our work to document and conserve the lichen biota of the Great Smoky Mountains (Lendemer et al. 2013) and the southern Appalachians as a whole (Tripp & Lendemer 2012). *Cladonia appalachensis* appears to be a rare species that is narrowly endemic to a specific habitat type in the southern Appalachians. It is known from a handful of populations, only one of which was confirmed as extant at the time of this study. Although limited in geographic range, additional sites exist within the Great Smoky Mountains that could potentially host extant populations of *C. appalachensis*. Therefore, the species likely represents a conservation concern that warrants immediate survey efforts to assess its current status and total distribution.

DISCUSSION. – *Cladonia appalachensis* is morphologically most similar to *C. peltastica* (Nyl.) Müll. Arg., a dominant species of terricolous lichen communities in white sand areas of the AmazonBasin (Ahti 2000). The new species differs from *C. peltastica* in chemistry (see below), ecology (occurrence on metal-rich rocks vs. white sand), and geographic distribution (high elevations of the southern Appalachian Mountains vs. low elevations of the Amazon Basin). *Cladonia peltastica* is chemically variable and characterized by the presence of usnic acid in addition some combination of barbatic, boninic, squamatic and or thamnolic acids (Ahti 2000), whereas *C. appalachensis* produces only squamatic acid without accessory usnic acid.

When Ahti (2000) treated *Cladonia peltastica* he included the name *C. humboldtii* Abbayes as a synonym. The type of that name is a squamulose morphotype with barbatic and squamatic acids that lacks usnic acid. Although chemically similar to this material, *C. appalachensis* does not produce barbatic acid in addition to squamatic acid, and is not squamulose. Recently, Ahti and Sipman (2013) described *C. recta* Ahti & Sipman from sandy soils and rotten wood of low elevation (<300 m) savannas in Guyana. That species is chemically identical to *C. appalachensis* in only producing squamatic acid. In addition to its ecology and geographic distribution, *C. recta* differs from the new species in having tall, slender podetia that form erect colonies. The morphological differences between *C. recta* and the new species are comparable to those between *C. recta* and *C. peltastica* (Ahti & Sipman 2013).

Considering that the new species occurs in montane habitats, produces squamatic acid, and has blackened podetial bases, it is also possible that the new species is related to *Cladonia crispata* (Ach.) Flot. and its relatives (Ahti 2000, Lendemer 2009). The tangled podetia that form cushion-like colonies, absence of funnels on the podetia, and the dispersed cortex would seem to separate *C. appalachensis* from members of that group. Nonetheless molecular data are needed to better understand affinities of this unusual species.

In the field *Cladonia appalachensis* is only likely to be confused with *C. furcata* (Huds.) Schrad., a ubiquitous species throughout the Appalachians (Brodo et al. 2001). Like *C. appalachensis*, *C. furcata* can have somewhat branched, slender, corticate podetia. *Cladonia furcata* differs from the new species morphologically in often having persistent primary squamules (vs. disappearing with age), usually having squamules on the podetia (vs. no squamules), and podetia without a distinctly blackened base (vs. distinctly blackened). It also differs chemically in the production of fumarprotocetraric acid instead of squamatic acid.

Additional specimens examined. – **U.S.A. NORTH CAROLINA.** SWAIN CO.: Great Smoky Mountains National Park, vicinity of Charlie's Bunion, 1972, on rock, *J.P. Dey 3163* (NY). **TENNESSEE.** SEVIER CO.: Great Smoky Mountains National Park, [without additional locality data], 1798 m, 28.vii.1962, on rock, *R.W. Becking 6207722* (NY); Great Smoky Mountains National Park, under Cliff Top, Mt. LeConte, 30.vi.1970, moist crevice in cliff in partial shade, *A.J. Sharp 473* (TENN); Great Smoky Mountains National Park, vicinity of Myrtle Point of Mt. LeConte, 1972, on soil, *J.P. Dey 3209* (GSMNP, NY); Great Smoky Mountains National Park, vicinity of Cliff Top of Mt. LeConte, 1972, on rock, *J.P. Dey 3301* (NY).

Selected specimens of Cladonia peltasticta with usnic and squamatic acids examined. – **BRAZIL. ACRE:** Mun. Cruzeiro do Sul, basin of Rio Juruá, 12.xii.2000, on sand, *D.C. Daly et al. 10636A[1]* (NY). **AMAZONAS:** near Ponta Negra, several kilometers upstream from Manaus, 29.i.1963, on soil, *G. Eiten et al. 5174* (NY). **PARÁ:** Serra do Cachimbo, approx. 10 km N of the Base Aérea do Cachimbo, 430-480 m,28.iv.1983, on soil, *L. Brako & M.J. Dibben 6308* (NY). **GUYANA:** Upper Mazaruni River region, Karowtipu Mountain, 1000 m, 23.iv.1987, on sand, *B. Boom & D. Gopaul 7665* (NY). **VENEZUELA. AMAZONAS:** Dept. Atabapo, Río Puruname, afluente derecho (oriental) del Río Orinoco, 100 m,3.vi.1982, on ground, *O. Huber & S.S. Tillett 6401* (NY).

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The Identity of *Sarcogyne hypophaea* (Nyl.) Arnold

KERRY KNUDSEN[1], JANA KOCOURKOVÁ[2] AND MARTIN WESTBERG[3]

ABSTRACT. – *Sarcogyne hypophaea* is recognized as the correct name for specimens referred to *Sarcogyne privigna* by A.H. Magnusson and later authors.

KEYWORDS. – Acarosporaceae, nomenclature, *Polysporina simplex*, taxonomy.

INTRODUCTION

It has long been recognized that *Lecidea privigna* Ach. is a synonym of *Polysporina simplex* (Taylor) Vězda (Magnusson 1935a, Knudsen & Kocourková 2011). Nonetheless, probably because he did not recognize the nomenclatural problem, Magnusson retained the name *Sarcogyne privigna* for this cosmopolitan taxon (Magnusson 1935a, 1935b). Using specimens identified as *S. privigna* by Magnusson, specimens from the Sonoran Desert Region of North America were identified as *S. privigna* (Knudsen & Standley 2007) though at the time those authors stated in the discussion that the name was misapplied.

In recent studies of *Sarcogyne plicata* H. Magn. and *S. privigna* by the first two authors, we examined all specimens annotated by Magnusson as *S. privigna* in his personal herbarium (now deposited at UPS) and treated the cosmopolitan taxon as *Sarcogyne privigna* auct. non (Ach.) A. Massal. (Knudsen & Kocourková 2011, Knudsen et al. 2013a). Working together with the third author, who is revising the Acarosporaceae of Fennoscandia, we agreed that the taxon identified as *S. privigna* by Magnusson is conspecific with the species described by Nylander (1870) as *Lecanora hypophaea* Nyl. which Nylander stated was definitely not conspecific with *Lecidea privigna* of Acharius.

MATERIAL AND METHODS

Specimens were studied from H, UCR, and UPS, using standard microscopy techniques as outlined by Knudsen et al. (2013b).

TAXONOMIC SECTION

Sarcogyne hypophaea (Nyl.) Arnold, Flora 53: 475. 1870.

≡ *Lecanora hypophaea* Nyl., Flora 53: 34. 1870. **TYPE**: Ad saxa granitica in Scotia, South Aberdeenshire, Braemar, *Crombie* s.n. (H-NYL 24570!, holotype [see figure 1A]).

≡ *Acarospora hypophaea* (Nyl.) Arnold, Flora 53: 469. 1870.

≡ *Biatorella hypophaea* (Nyl.) Blomb. & Forssell, Enum. Pl. Scand. p. 83. 1880.

≡ *Biatorella privigna* f. *hypophaea* (Nyl.) Zahlbr., Cat. Lich. Univ. 10: 418. 1939.

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[1] KERRY KNUDSEN – Herbarium, Department of Botany and Plant Sciences, University of California, Riverside, CA 92521-0124, U.S.A. – e-mail: kerry.knudsen@ucr.edu

[2] JANA KOCOURKOVÁ – Department of Ecology, Faculty of Environmental Sciences, Czech University of Life Sciences, Prague, Kamýcká 129, Praha 6 – Suchdol, CZ–165 21, Czech Republic. – e-mail: kocourkovaj@fzp.czu.cz

[3] MARTIN WESTBERG – Department of Botany, Swedish Museum of Natural History, P.O. Box 50007, SE-104 05 Stockholm, Sweden. – e-mail: Martin.Westberg@nrm.se

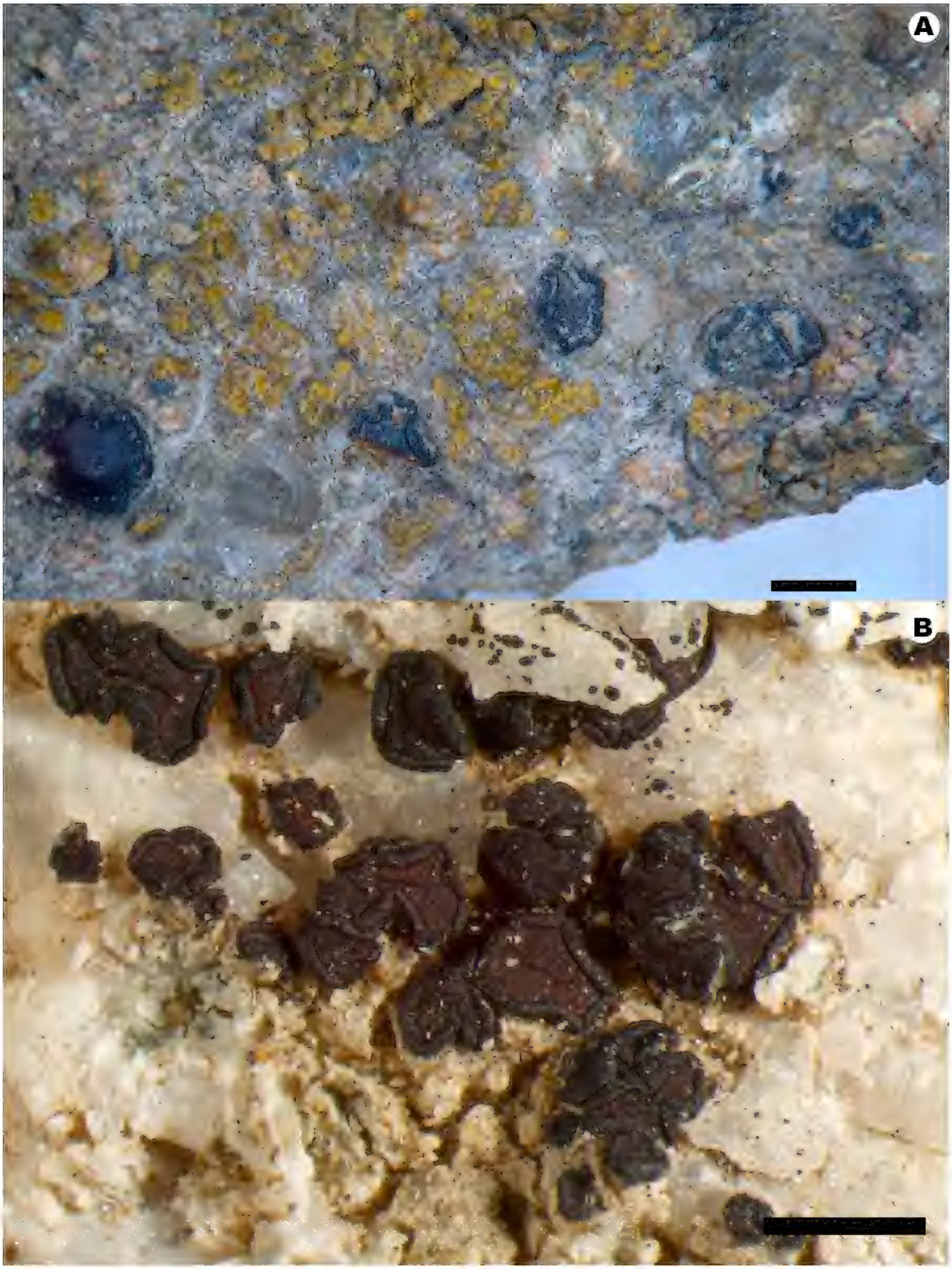

Figure 1, *Sarcogyne hypophaea*. A, holotype (*Crombie s.n.*, H-NYL; photo by M. Westberg, scale = 1.0 mm). B, typical specimen of *S. hypophaea* from Joshua Tree National Park, Eagle Mountains, ridge above Lost Palm Canyon, on granite (*Knudsen 15123 & Kocourková*, UCR; photo by J. Kocourková; scale = 1.0 mm).

DISCUSSION. – For descriptions of this taxon see Magnusson (1935a, 1935b), Clauzade and Roux (1985), Golubkova (1988), Knudsen and Standley (2007), and Fletcher and Hawksworth (2009). A further discussion of the taxonomy of the species is available in Knudsen and Kocourková (2011) with a picture of an average specimen. A typical specimen of *Sarcogyne hypophaea* is also illustrated here in figure 1B.

In examining specimens from Germany, central Europe, and North America we have seen several taxa misidentified as *Sarcogyne privigna*, including material we could not identify to species and even occasionally a *Lecidea* species. Material from coastal southern California collected by Hasse was originally identified for him by Nylander as *Lecanora hypophaea* and treated as *Biatorella hypophaea* in his historic lichen flora of southern California (Hasse 1913).

Arnold placed *Lecanora hypophaea* in two different genera, *Acarospora* and *Sarcogyne*, both with a question mark (Arnold 1870). We do not consider Arnold's use of question marks to be an indication of taxonomic doubt pertaining to the combinations he proposed. Rather, we consider his use of question marks as an indication that the he intended for to create two alternative names in the genera *Acarospora* and *Sarcogyne*, both of which he accepted (McNeill et al. 2012, Arts. 36.1 and 36.2). Thus both of these combinations should be considered to have been validly published by Arnold in 1870. The name was originally published as *Lecanora hypophaca,* a typographical error (Nylander 1870) as is attested by the handwriting on the holotype, Arnold's use of the epithet "*hypophaea*" (Arnold 1870), and also Hasse's use of the same spelling "*hypophaea*" (Hasse 1913) which would have been based on correspondence from Nylander. In 1933 A.H. Magnusson annotated the holotype of *L. hypophaea* as a variation of *Biatorella privigna*, thus showing that Magnusson had connected these two names long ago.

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A monograph of the crustose members of the genus *Lepraria* Ach. s. str. (Stereocaulaceae, Lichenized Ascomycetes) in North America north of Mexico

JAMES C. LENDEMER[1]

ABSTRACT. – A monograph of the crustose members of the lichen genus *Lepraria* s. str. present in North America north of Mexico is provided. A key to all the crustose members of *Lepraria* s.l. present in the study area is included, and full descriptions and species accounts are provided for the twenty-six species belonging to the genus in a strict sense. Additionally, color illustrations and distribution maps of all the species treated are provided. A new thallus morphotype, the *lanata*-type, is defined to describe the thallus of *L. lanata*. *Lepraria leprolomopsis* is reported for the first time from North America (Alabama and West Virginia, U.S.A.). *Lepraria santosii* is placed in synonymy with *L. lobificans* and the name *L. finkii* is taken up for the common species previously referred to as *L. lobificans*.

KEYWORDS. – sterile crusts, granule, soredia, *Leprocaulon*, *Leproloma*, biogeography.

INTRODUCTION

Lichens are a remarkable group of fungi that have evolved a semi-parasitic lifestyle involving the capture and propagation of an alga (photobiont). Lichens are also a polyphyletic group including representatives of multiple clades within the diverse fungal domain that have evolved the same unique lifestyle. The rampant and repeated evolution of taxa throughout these clades that reproduce asexually through fragmentation, and a corresponding suppression of sexual reproduction, is without a doubt one of the most intriguing aspects of these organisms. From a pragmatic standpoint it is somewhat intuitive that organisms dependent on the capture of another organism would evolve a method of reproduction that assures the co-dispersal of both together. The widespread nature of this phenomenon in lichen forming fungi is nonetheless perplexing considering the potential long-term effects of sterility and clonal reproduction.

Unfortunately, the above phenomenon is also one of the least explored areas of lichen biology. This is largely due to that fact that the taxa that reproduce asexually via lichenized diaspores are among the most poorly understood and chronically understudied groups of lichens. Although many factors contributed to the present situation, the most salient is the fact that the higher level taxonomic framework for lichens is based largely on characters of the sexual fruiting bodies, structures that are typically lacking in the majority of species that reproduce asexually.

The genus *Lepraria* Ach. s.l. comprises a group of approximately sixty asexually reproducing species that have continued to evolve and speciate despite an apparent absence of sexual reproduction. In light of the unresolved higher level taxonomy and poor understanding of species delineation in *Lepraria*, the genus serves as a microcosm for both the problems currently hindering study of asexually reproducing lichens, and their potential solutions. Recognizing that a better understanding of *Lepraria* could elucidate a path for progress in other asexually reproducing taxa, I undertook a revision of this group in North America north of Mexico as the topic of my dissertation. The culmination of this study is the present publication, a monograph of the genus *Lepraria* s. str. in the aforementioned region.

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[1] JAMES C. LENDEMER – Institute of Systematic Botany, The New York Botanical Garden, Bronx, NY 10458-5126, U.S.A. – email: jlendemer@nybg.org

CIRCUMSCRIPTION OF THE STUDY GROUP (I.E., WHAT IS AND IS NOT *LEPRARIA* S. STR.?)

This monograph is an attempt to synthesize more than five years of research on *Lepraria* s.l. in North America and abroad. When I began this study, *Lepraria* s.l. was a broadly circumscribed, evolutionarily heterogeneous assemblage of species united by an apparent lack of sexual reproduction and the presence of a crustose leprose thallus (Lendemer 2010a, 2011a). Though there was evidence that the genus was polyphyletic (Ekman & Tønsberg 2002; Nelsen et al. 2008) no alternative scheme had been proposed. A monophyletic core group representing *Lepraria* s. str. had been proposed by Ekman and Tønsberg (2002) based on an analysis of nuITS sequence data. Though additional data were needed to confirm and elucidate this circumscription. Further, studies were also required to determine the phylogenetic affinities of the taxa that had been classified in *Lepraria* s.l. but that data indicated did not belong to *Lepraria* s. str. Thus, it was necessary to assemble a molecular dataset with broad taxon sampling, and conduct extensive molecular phylogenetic analyses, before proceeding with a revision of *Lepraria* s. str. A detailed account of the results of this work has been published by Lendemer and Hodkinson (2013). However, it is also summarized here to provide a context for the coverage of this monograph.

Lendemer and Hodkinson (2013) conducted a series of molecular phylogenetic analyses of sequence data from the mtSSU region of a taxonomically broad sampling of *Lepraria* s.l. as well as other groups that were thought to have affinities to the genus (i.e., *Leprocaulon* Nyl.). These analyses inferred a large monophyletic group of species embedded in a clade containing sequences of the type of *Lepraria*, *L. incana* (L.) Ach. This clade corresponds to *Lepraria* s. str. and was recovered as sister to the genus *Stereocaulon* Ach., with strong support as a member of the family Stereocaulaceae. Interestingly, sequences of species of *Leprocaulon* lacking usnic acid were also recovered as members of the *Lepraria* s. str. clade. As such the concept of *Lepraria* was expanded to include all the members of *Leprocaulon* except for the type species *L. microscopicum* (Vill.) Games *ex* D. Hawksw. (= *L. quisquiliare* (Leers) M. Choisy). In this new circumscription *Lepraria* s. str. comprises sterile members of the Stereocaulaceae with crustose leprose and crustose fruticose thalli.

The same series of analyses that led to the transfer of the majority of species of *Leprocaulon* to *Lepraria* also resulted in the dispersal to other genera in other families of all the studied members of *Lepraria* s.l. that produce argopsin, pannarin, or usnic acid. Ironically, many of these species were transferred to *Leprocaulon* because molecular phylogenetic analyses recovered their representative mtSSU sequences in a strongly supported clade with sequences of the type species of that genus (a relationship supported by morphological and chemical characters as well as biogeography). The results of these same analyses indicated a placement of *Leprocaulon* as sister to *Halecania* H. Mayrhofer in a previously unrecognized family within the Teloschistales. We also recovered several usnic acid-producing members of *Lepraria* s.l. in other families, namely the Lecanoraceae and Pilocarpaceae.

Based on the results summarized above, the present monograph has been restricted to the crustose species of *Lepraria* s.str. occurring in North America north of Mexico. This treatment specifically excludes the species remaining in *Lepraria* s.l. whose chemical profiles indicate they belong elsewhere in other families (i.e., all species with isousnic acid, usnic acid, and xanthones). A brief listing of these taxa is presented in the section detailing excluded species that immediately follows the species accounts below. Until molecular data are generated for these taxa they cannot be placed elsewhere unequivocally. The transfer of these species to another genus would be no more informative than retaining them in *Lepraria* and potentially result in superfluous nomenclatural acts. While the retention of these taxa in *Lepraria* s.l. is not an ideal solution because it maintains a polyphyletic circumscription of the genus, it is nonetheless the most parsimonious solution to a vexing problem. The fruticose members of *Lepraria* s.str. that were previously treated in *Leprocaulon* are also not treated here because they were not originally intended to form part of this study. These taxa are poorly understood and require substantial additional study.

MATERIALS AND METHODS

Field studies. – Intensive fieldwork for this study was carried out throughout the Appalachian Mountains (dozens of trips), six trips to southern California, four trips to the Canadian Maritimes (Newfoundland and New Brunswick), two trips to the Coastal Plain of the southeastern United States, two trips to central California (coast and Sierra Nevada Mountains), two trips to the Great Lakes Region

(Ontario and Quebec), and one trip each to northern Arizona, New England (Maine, Vermont), the Ozark Ecoregion, the Pacific Northwest (British Columbia), and the western boreal forests (Yukon). Supplementary field studies were also carried out in temperate regions of Chile and in Tasmania, Australia. Also, not included in the tally above are the numerous collecting trips prior to beginning my dissertation studies.

Large scale field studies are the corner stone of any solid taxonomic revision (Ahti 2000, Tehler 1983), and after more than five years of study I am convinced they are essential to understanding *Lepraria*. During my fieldwork in North America I conducted intensive collecting trips in multiple limited geographic areas of as many major biogeographic provinces as possible. This sampling scheme resulted in observations and collections with high sample size on a small scale, but roughly even coverage at a larger scale. Thus, the morphological and ecological variability of a given species could be assessed at both the population level and throughout its range. This is particularly relevant in *Lepraria* because it became clear over time that most species are ecologically and morphologically consistent throughout their range, but aberrant thalli or populations can occur when the species occupy certain habitats. For instance typically saxicolous species can occur on bark or lignum in habitats with extremely high constant humidity. Similarly, species with aggregate thalli occurring in such habitats can develop abnormally thick prothalli that give the appearance of a hypothallus. The converse is also true, when species with placodioid thalli occur in unusually dry habitats, the hypothallus can be poorly developed and the morphology difficult to interpret. Clearly these phenomena are no different from when a plant or animal grows in an unusual habitat and produces an aberrant form. In other groups of organisms these cases are simply considered to represent biological reality and are not used to justify the conclusion that the taxa are devoid of morphological characters. The research conducted for the present treatment supports this approach and strongly refutes the notion that *Lepraria*, let alone other groups of lichens, lacks non-molecular characters that can be used to distinguish monophyletic taxa.

Collection and preparation of voucher specimens. – During the fieldwork outlined above an effort was made to intensively collect *Lepraria* at every site that was visited (a total of >460 sites were visited in North America; figure 1 herein). This involved collecting representatives of all thalli that appeared different (in color, texture, and ecology) in the field. In order to decrease the potential for mixed collections, each collection consisted of a single thallus, or multiple thalli that were growing together side-by-side. Although this scheme often resulted in repeated sampling of the same taxon at a given site (e.g., many collections of *L. finkii*) it also led to the collection of many species that appear to be rare. Such large scale replicate sampling, repeated across many sites, is pivotal to adequately assessing *Lepraria* diversity in a given region. This is particularly clear when one considers that the four most common species were represented in this study by 1177 (*L. finkii*), 692 (*L. neglecta*), 329 (*L. caesiella*), and 243 (*L. normandinoides*) specimens. Whereas all but five of the remaining twenty two species were represented by between ten and one hundred collections, and eight of those were represented by between ten and fifty specimens.

An additional focus of my fieldwork was to collect ample voucher specimens for use in chemical, morphological, and molecular studies. The ideal voucher specimen of most lichens comprises enough material to fit comfortably inside a standard 4 × 6” herbarium packet (Brodo et al. 2001). However, for *Lepraria* a specimen of this size can be difficult to identify unless it is from a region where the *Lepraria* biota is already well documented. Thus, during my field studies I typically collected enough material to fit on a 5 × 8” paper card. When collecting specimens I attempted to take whole thalli when possible, and to always include large intact pieces of the thallus showing the transition from the edge to the center. Fresh specimens were also always carefully packed to avoid damage or alteration to the morphology from crushing during transport from the field. Only in extreme conditions was it deemed acceptable to scrape the thallus from the substrate.

Specimens examined. – As in my previous contributions on *Lepraria* s.l., this study is based primarily on material in the herbarium of The New York Botanical Garden (NY), supplemented by material received on loan from the following herbaria: CANL, COLO, CONN, DUKE, FH, GZU, H, KANU, MIN, MSC, SBBG, UCR, and UTEP. A total of 3847 specimens (3351 *Lepraria* s. str. from North America; 496 species not belonging to *Lepraria* s. str. or species of *Lepraria* s. str. from outside the study area) were examined as part of this study including >1600 specimens collected by myself during my extensive field studies of *Lepraria* throughout North America. To date these total 1.5 years in the field and span the period August, 2007 to August, 2011.

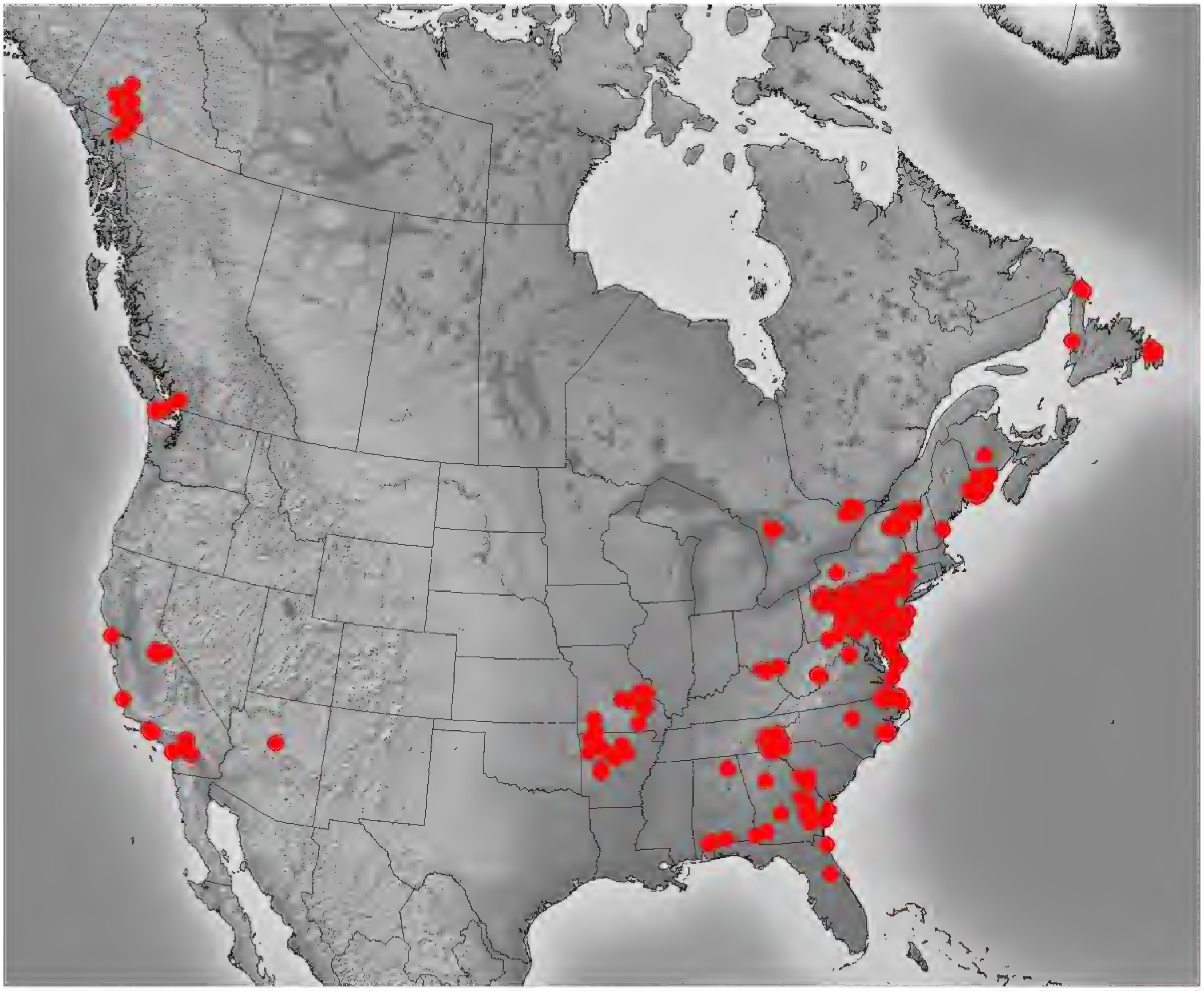

Figure 1, North American collection localities visited by the author as part of this study.

Through the above field studies the author has been able to gather firsthand observations of ecology and morphology for all the species known to occur in North America. All the data associated with the voucher specimens examined for this study have also been databased at NY. The data for specimens deposited in that institution are accessible via the NYBG Virtual Herbarium (http://sciweb.nybg.org/science2/hcol/lena/index.asp). The data for vouchers from other institutions are not searchable via the same online portal; however these are available from the author upon request. It is important to note that the locality data for the majority of specimens examined, both those at NY and those from other institutions, were also georeferenced as part of this study. The distribution maps presented in this treatment are based on the specimens examined prior to February, 2012 at which time all data were summarized in preparation for submission of the manuscript.

Chemical methods. – The chemistry of each specimen was studied as outlined by Lendemer et al. (2008). Specifically this involved analyses of a subsample with Thin Layer Chromatography at least one time, though often more than once. One of the most common problems encountered by those attempting to identify *Lepraria* is that subsamples used for chemical analyses consist of mixtures. Care must be taken to use only the smallest sample needed, and to remove this sample from an area where it appears only a single thallus is present. When one encounters a "novel" chemical profile that appears to combine those observed for one or more species the results should be assumed to be due to contamination. Even with repeated sampling from the same, and multiple, collections these results should be treated with a high degree of skepticism. The description of new taxa based on these data alone should also be considered highly suspect.

All specimens were examined initially using solvent systems A and/or C following Culberson and Kristinsson (1970) to determine which secondary compounds were present. For many species additional analyses with other solvent systems and known chemical standards were required to determine where specific substances were present or absent. Such additional analyses were typically conducted following the peanut butter jar method outlined by Lendemer (2011b). Specifically these supplementary analyses were as follows:

1) Solvent A was consistently used to confirm the presence of, and discriminate between, dibenzofurans. Reference specimens of *Lepraria alpina* (= *L. neglecta*), *L. diffusa*, *L. membranacea*, and *L. vouauxii* were used as standards for these analyses.

2) Solvent C was used to reexamine samples that initially showed the presence of one or more of the following three fatty acids: nephrosteranic acid, roccellic/angardianic acid, and rangiformic/jackinic acid. Pallidic acid was always assumed to be present as an accessory to zeorin in *Lepraria caesiella* and *L. harrisiana*, because such samples of these species were not reanalyzed.

3) Solvent G (Tønsberg 1992) was consistently used to separate fumarprotocetraric acid and protocetraric acid. Although these substances can be determined with some degree of certainty using solvent C, in cases where it was necessary to determine exactly which one was present (i.e., *Lepraria normandinoides* vs. *L. oxybapha*) a subsample was also run in solvent G for confirmation.

4) Although xanthones are not present in members of *Lepraria* s. str., two species that produce these substances are retained in *Lepraria* s.l. here. Xanthones were detected using the methodology outlined in extensive detail by Lendemer (2010a).

It should be noted that spot tests (see Brodo et al. 2001) were rarely employed in this study because they often produce inconclusive results in *Lepraria*. The reason for this is that secondary compounds appear to be produced in highly variable concentrations in *Lepraria*, both in the same thallus and across different populations. If one does use spot tests, I recommend that they be conducted on an acetone extract of the thallus spotted onto filter paper. This method is used widely in the identification of the genera *Alectoria* and *Bryoria* (Brodo & Hawksworth 1977) for the same reasons it should be employed in *Lepraria*. Using this methodology and the keys published by Lendemer (2010a, 2010b) one should arrive at an identification with some degree of certainty. However TLC is always required to confirm identification.

Morphological methods. – Morphological studies were carried out using the methodology outlined in detail by Lendemer et al. (2008) with the SEM methods as corrected by Lendemer and Elix (2010). Descriptive morphological terminology follows Lendemer (2011a). A summary table of the thallus type present in each species treated here is presented in Appendix A.

Measurements of granule diameter, hyphal width, and photobiont cell diameter are given as the average (xbar) ± 1 standard deviation (sd) and bounded by the extreme observed values, or [smallest observed]-(xbar-1sd)-xbar-(xbar+1sd)-[largest observed]. The number of observations (*n*) is also provided. All measurements were based on fresh material (collected within the last 1–2 years) to minimize the potential impacts of long-term storage on the delicate morphological structures involved. In the cases of *Lepraria leprolomopsis* and *L. xerophila* measurements of the above structures are expressed as simple ranges because of the paucity of fresh material that was examined. The reader should refer to Appendices B through E for tabular summary and graphical representations of the size ranges of granule diameter, hyphal width, and photobiont cell diameter in the species treated here.

Abbreviations. – Throughout this treatment the terms *sensu stricto* and *sensu lato* are abbreviated as "s. str." and "s.l." respectively. The use of these abbreviations is intended to help orient the reader as to whether the taxon is being referred to in its strictest sense (i.e., s. str.) or in a broader sense (i.e., s.l.). In the case of references to the genus *Lepraria*, *Lepraria* s. str. refers to the monophyletic group of species that have been shown to belong to the family Stereocaulaceae. Whereas the use of *Lepraria* s.l. refers to the genus in a broader, more historical sense, that includes species which do not belong to *Lepraria* s. str. in the Stereocaulaceae.

TAXONOMIC TREATMENT

TLC KEY TO THE CRUSTOSE LEPROSE SPECIES OF *LEPRARIA* S.L.

The key provided below is divided into *Lepraria* s.l. and *Lepraria* s. str.; only the members of the latter group are treated here (for further discussion see Lendemer & Hodkinson 2013; for a list of species not treated here see the "excluded species" section that follows the taxonomic treatment herein). This key assumes that TLC data are available for the specimen being identified. Users who wish to utilize spot tests should proceed to the key following this one.

1. Thallus with argopsin, isousnic acid, pannarin, or usnic acid (all members of *Lepraria* s.l.) **2**

2. Argopsin present; southern California .... ***Leprocaulon santamonicae***

2. Argopsin absent; distribution various **3**

3. Pannarin present **4**

4. Granules small, <0.1 mm in diameter; widespread in North America .... ***Leprocaulon adhaerens***

4. Granules large, >0.1 mm in diameter; rare, restricted to soil communities in coastal southern California .... ***Leprocaulon terricola***

3. Pannarin absent **5**

5. Isousnic acid and obtusatic acid present; rare and restricted to the Appalachian Mountains .... ***Lepraria moroziana***

5. Isousnic acid and obtusatic acid absent; distribution various **6**

6. Usnic acid and barbatic acid present, zeorin absent; rare and restricted to the Ozark Ecoregion .... ***Lepraria barbatica***

6. Usnic acid and zeorin present, barbatic acid absent; distribution various **7**

7. Xanthones present **8**

8. Thallus placodioid-type; usnic acid, zeorin, thiophaninic acid, and arthothelin present .... ***Lepraria disjuncta***

8. Thallus aggregate-type; usnic acid, zeorin, and 5,7-dichloro-3-*O*-methylnorlichexanthone present .... ***Lepraria xanthonica***

7. Xanthones absent **9**

9. Thallus placodioid-type; rare and restricted to southern California .... ***Leprocaulon textum***

9. Thallus aggregate-type; throughout mountainous regions of California, more widespread(?) .... ***Leprocaulon knudsenii***[2]

1. Thallus without argopsin, isousnic acid, pannarin, or usnic acid **10**

10. Thamnolic acid or squamatic acid present; northern to central Florida and adjacent Georgia **11**

11. Thamnolic acid present .... ***Lepraria aurescens***

11. Squamatic acid present .... ***Lepraria squamatica***

10. Thamnolic acid and squamatic acid both absent; distribution various **12**

12. Alectorialic acid present **13**

13. Thallus placodioid-type; granules ecorticate; in sheltered microhabitats .... ***Lepraria eburnea***

13. Thallus aggregate-type; granules pseudocorticate; in exposed microhabitats .... ***Lepraria neglecta* (alectorialic acid chemotype)**

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[2] Note that following the key in Lendemer (2010) specimens would key out here under the name *Lepraria ecorticata* (J.R. Laundon) Kukwa. As has been discussed by Lendemer and Hodkinson (2013) this species should be tentatively excluded from North America. The populations from California were described as a new species, *Leprocaulon knudsenii*. The species of *Lepraria* s.l. that have aggregate thalli and produce usnic acid are poorly understood and desperately in need of a detailed taxonomic revision.

12. Alectorialic acid absent **14**

14. Stictic acid or norstictic acid present **15**

15. Norstictic acid present; stictic acid absent .... ***Lepraria neglecta* (norstictic acid chemotype)**

15. Stictic acid present; norstictic acid absent **16**

16. Thallus placodioid-type **17**

17. Zeorin present; ubiquitous in most regions of North America .... ***Lepraria finkii***

17. Zeorin absent; rare in the central/southern Appalachian Mountains .... ***Lepraria leprolomopsis***

16. Thallus aggregate-type **18**

18. Granules ecorticate; in sheltered microhabitats .... ***Lepraria elobata* (stictic acid chemotype)**

18. Granules pseudocorticate; in exposed microhabitats .... ***Lepraria neglecta* (stictic aicd chemotype)**

14. Stictic acid and norstictic acid both absent **19**

19. Salazinic acid present .... ***Lepraria elobata* (salazinic acid chemotype)**

19. Salazinic acid absent **20**

20. Divaricatic acid present **21**

21. Zeorin absent; thallus placodioid-type; nordivaricatic acid present in high concentrations; on non-calcareous rocks; eastern and central North America .... ***Lepraria cryophila***

21. Zeorin present; thallus aggregate-type; nordivaricatic acid absent or present in very low concentrations; on hardwoods or conifers; distribution various **22**

22. Eastern North America; nordivaricatic acid absent .... ***Lepraria hodkinsoniana***

22. Western North America; nordivaricatic acid present in low concentrations .... ***Lepraria pacifica***

20. Divaricatic acid absent **23**

23. Fumarprotocetraric acid or protocetraric acid present **24**

24. Granules forming massive spherical aggregations >0.1 in diameter; protocetraric acid and roccellic/angardianic acid present; rare and restricted to high elevations of the southern Appalachian Mountains .... ***Lepraria lanata***

24. Granules not as above; chemistry and distribution various **25**

25. Thallus aggregate-type; fumarprotocetraric acid present **26**

26. Atranorin present; granules pseudocorticate; in exposed microhabitats .... ***Lepraria neglecta* (fumarprotocetraric acid chemotype)**

26. Atranorin typically absent; granules ecorticate; in sheltered microhabitats **27**

27. Roccellic/angardianic acid present; Pacific Northwest .... ***Lepraria torii***

27. Roccellic/angardianic acid absent; southeastern Coastal Plain .... ***Lepraria friabilis***

25. Thallus placodioid-type; fumarprotocetraric acid or protocetraric acid present **28**

28. Thallus *finkii*-type, margins not rounded with a distinct lip; roccellic/angardianic acid absent; Pacific Northwest .... ***Lepraria nivalis***

28. Thallus *normandinoides*-type; margins rounded, with a distinct lip; roccellic/angardianic acid present **29**

29. Protocetraric acid present .... ***Lepraria normandinoides***
29. Fumarprotocetraric acid present .... ***Lepraria oxybapha***
23. Fumarprotocetraric acid and protocetraric acid both absent **30**

30. Psoromic acid present .... ***Lepraria neglecta* (psoromic acid chemotype)**
30. Psoromic acid absent **31**

31. Zeorin present **32**

32. Thallus placodioid-type .... ***Lepraria harrisiana***
32. Thallus aggregate-type .... ***Lepraria caesiella***

31. Zeorin absent **33**

33. Dibenzofurans present **34**

34. Thallus aggregate type **35**

35. Granules ecorticate; in sheltered microhabitats; atranorin absent, oxypannaric acid-2-methylester present .... ***Lepraria diffusa***
35. Granules pseudocorticate; in exposed habitats; atranorin and porphyrilic acid present .... ***Lepraria neglecta* (porphyrilic acid chemotype)**

34. Thallus placodioid type **36**

36. Pannaric acid present .... ***Lepraria membranacea***
36. Pannaric 6-methylester or norascomatic acid present **37**

37. Norascomatic acid present .... ***Lepraria xerophila* (rare chemotype)**
37. Pannaric 6-methylester present **38**

38. Coastal habitats in southern California; thallus *xerophila*-type, margins rounded and with a raised lip .... ***Lepraria xerophila***
38. Not in the above habitats; thallus *finkii*-type, margins discrete, but not rounded and with a raised lip .... ***Lepraria vouauxii***

33. Dibenzofurans absent **39**

39. Nephrosteranic acid present; granules frequently with projecting prothalline hyphae persisting to maturity .... ***Lepraria rigidula***
39. Nephrosteranic acid absent; granules typically not retaining prothalline hyphae into maturity **40**

40. Roccellic/angardianic acid and rangiformic/jackinic acid both absent .... ***Lepraria neglecta* (fatty acid chemotypes)**
40. Roccellic/angardianic acid or rangiformic/jackinic acid present **41**

41. Thallus placodioid-type, with rounded margins and a crisped lip; roccellic/angardianic acid present.... .... ***Lepraria normandinoides***
41. Thallus aggregate type, morphology not as above; roccellic/angardianic acid present or absent **42**

  42. Roccellic/angardianic acid present in addition to rangiformic/jackinic acid.................... .... ***Lepraria jackii***
  42. Roccellic/angardianic acid absent, rangiformic/jackinic acid present .... ***Lepraria humida***

SPOT-TEST KEY TO THE CRUSTOSE LEPROSE SPECIES OF *LEPRARIA* S.STR.

The key provided below is divided into *Lepraria* s.l. and *Lepraria* s. str.; only the members of the latter group are treated here (for further discussion see Lendemer & Hodkinson 2013; for a list of species not treated here see the "excluded species" section that follows the taxonomic treatment herein). While this key relies exclusively on spot tests, geography, and morphology it should be noted that there are couplets included where TLC is required for a confident identification. Further, if one wants to be certain of any identification in *Lepraria* TLC data are essential. Users of this key should compare their specimen to the photographs of the species provided herein as these should aid significantly in identification. It should also be noted that most species producing dibenzofurans (i.e., *L. diffusa, L. membranacea* and *L. vouauxii*) are keyed out as P+ orange below, although some thalli may react P-. These species have a distinctive yellow to orange hue when fresh due to the presence of dibenzofurans. Some species that produce dibenzofurans such as porphyrilic acid (*L. neglecta*) or the unknown substance that is often found in *L. finkii* do have this yellow to orange hue however. Similiarly, a yellowish hue is often seen in *L. eburnea*, which produces alectorialic acid rather than dibenzofurans. Although only *L. vouauxii* is common enough to be routinely encountered, care should be taken to keep in mind the problems associated with the identification of dibenzofuran producing species using spot tests alone.

1. Thallus K- and KC+ golden yellow (usnic acid present); thallus distinctly yellow-green in color (all species do not belong to *Lepraria* s. str.. **2**

  2. Thallus UV+ blue-white (barbatic acid or obtusatic acid present.. **3**

    3. Occurring in the Appalachian Mountains, common at high elevations in the southern portions and rare at lower elevations in the northern portions, typically associated with spruce (*Picea*) forests; on shaded non-calcareous rocks and organic matter in overhangs or the sheltered bases of mature spruce and birch (*Betula*); thallus typically with patches of yellow-orange pigment that are K+ reddish-purple; isousnic acid and obtusatic acid present .... ***Lepraria moroziana***
    3. Occurring in the Ozark Ecoregion, very rare; on shaded non-calcareous rocks on vertical faces or in overhangs; thallus without yellow-orange pigments that are K+ reddish-purple; usnic acid and barbatic acid present.. ***Lepraria barbatica***

  2. Thallus UV- or UV+ dull orange (barbatic acid or obtusatic acid absent) **4**

    4. Eastern North America.. **5**

      5. Thallus UV- (xanthones absent); usnic acid and often zeorin present ....**cannot be identified to species w/ certainty but *Lepraria ecorticata* is frequently used**
      5. Thallus UV+ dull orange (xanthones present.. **6**

        6. Thallus placodioid-type; typically on calcareous rocks; usnic acid, zeorin, thiophaninic acid, and arthothelin present .... ***Lepraria disjuncta***
        6. Thallus aggregate-type; typically on non-calcareous rocks; usnic acid, zeorin, and 5,7-dichloro-3-*O*-methylnorlichexanthone present .... ***Lepraria xanthonica***

    4. Western North America **7**

7. Thallus placodioid-type; rare and restricted to southern California ...... ***Leprocaulon textum***

7. Thallus aggregate-type; throughout mountainous regions of California, more widespread(?) .... ***Leprocaulon knudsenii***

1. Thallus not borh K- and KC+ golden yellow (usnic acid absent); thallus gray to blue-gray in color, sometimes with a greenish hue or yellow hue (the latter due to certain dibenzofurans or alectorialic acid) but never yellow-green due to the presence of usnic acid **8**

8. Thallus UV+ blue-white (divaricatic, obtusatic or squamatic acid present)....................................... **9**

9. Western North America .... ***Lepraria pacifica***

9. Eastern North America... **10**

10. Thallus aggregate-type; Appalachian Mountains or widespread **11**

11. Common and widespread, especially at middle-low elevations throughout temperate, and into boreal eastern North America; granules 30-40 µm in diameter; thallus without yellow-orange pigment that is K+ reddish-purple; divaricatic acid and zeorin present .... ***Lepraria hodkinsoniana***

11. Restricted to the Appalachian Mountains and only common at high elevations in the southern portions; granules ~10 µm in diameter; thallus typically with yellow-orange pigment that is K+ reddish-purple; isousnic acid and obtusatic acid present....................... .... ***Lepraria moroziana***

10. Thallus placodioid-type; temperate (Appalachian Mountains/northern Boreal) or subtropical (central Florida to southern Georgia) **12**

12. Temperate; thallus C+ pink/red (nordivaricatic acid present)......... ***Lepraria cryophila***

12. Tropical; thallus C- (squamatic acid present) .... ***Lepraria squamatica***

8. Thallus UV- or UV+ orange (above substances absent)... **13**

13. Thallus C+ and/or KC+ pink/red (alectorialic or lecanoric acid present)................................ **14**

14. Thallus P-, C+ pink/red, KC+ pink/red (lecanoric acid present); very rare and restricted to the Sonoran Desert area .... ***Lepraria lecanorica***

14. Thallus P+ yellow, C-, KC+ pink/red (alectorialic acid present); common and widespread **15**

15. Thallus placodioid-type; granules fluffy, without a pseudocortex; northern/boreal, extending southward in mountainous regions.. ***Lepraria eburnea***

15. Thallus aggregate-type; granules compact, with a pseudocortex; widespread throughout... ***Lepraria neglecta*** **(alectorialic acid chemotype)**

13. Thallus C- and KC- or KC+ golden yellow (alectorialic or lecanoric acid absent)................. **16**

16. Thallus P+ orange or P+ red **17**

17. Thallus placodioid-type **18**

18. On soil in soil crusts along the Pacific Coast from Mexico to central California .... ***Lepraria xerophila***

18. Not on soil in soil crusts along the Pacific Coast... **19**

19. Thallus K+ instantly lemon yellow, P+ orange (thamnolic acid present); subtropical Florida and adjacent coastal Georgia .... ***Lepraria aurescens***

19. Thallus not K+ instantly lemon yellow and P+ orange (thamnolic acid absent); mostly not in subtropical Florida and adjacent coastal Georgia (only *L. finkii* present on that region) **20**

20. Thallus P+ red (fumarprotocetraric or protocetraric acid present......... **21**

21. Thallus *finkii*-type, without a "crisped" lip along the margins; Pacific Northwest .... ***Lepraria nivalis***

21. Thallus *normandinoides*-type, with a "crisped" lip along the margins.. **22 (TLC required)**

22. Protocetraric acid present .... ***Lepraria normandinoides***

22. Fumarprotocetraric acid present................. ***Lepraria oxybapha***

20. Thallus P+ orange (stictic acid or dibenzofurans present).................... **23**

23. Thallus green or blue in color, without a distinct light yellow to orange hue (stictic acid present) **24**

24. Zeorin present (TLC required); ubiquitous species in eastern North America .... ***Lepraria finkii***
24. Zeorin absent (TLC required); very rare, known only from two sites in Alabama and West Virginia .... ***Lepraria leprolomopsis***

23. Thallus white or gray, with a distinct light yellow to orange hue (dibenzofurans present) **25**

25. Pannaric acid present as the major substance (TLC required); boreal/northern, rare .... ***Lepraria membranacea***
25. Pannaric 6-methylester acid present as the major substances (TLC required); widespread, infrequent .... ***Lepraria vouauxii***

17. Thallus aggregate type **26**

26. Thallus P+ red (fumarprotocetraric or protocetraric acid present) **27**

27. Granules compact, with a pseudocortex; in exposed habitats ....***Lepraria neglecta*** **(fumarprotocetraric acid chemotype)**
27. Granules fluffy, without a well-developed pseudocortex; in sheltered or protected habitats **28**

28. Granules aggregating to form large (> 100 µm wide) structures resembling cotton balls; restricted to high elevation localities in the southern Appalachian Mountains .... ***Lepraria lanata***
28. Granules not aggregating to form large structures resembling cotton balls; absent from high elevation localities in the southern Appalachian Mountains **29**

29. Southeastern Coastal Plain .... ***Lepraria friabilis***
29. Northern boreal regions (especially Pacific Northwest) .... ***Lepraria torii***

26. Thallus P+ orange (argopsin, dibenzofurans, pannarin or stictic acid present)... **30**

30. Granules compact, with a pseudocortex; in exposed habitats **31**
31. On soil in biological soil crusts at low elevations in southern California; pannarin and zeorin present .... ***Leprocaulon terricola***
31. On rocks and broyphytes at middle to high elevations especially in southern California; atranorin, fatty acids, and stictic acid present .... ***Lepraria neglecta*** **(stictic acid chemotype)**
30. Granules fluffy, without a well-developed pseudocortex; in sheltered or protected habitats **32**

32. Species of montane or northern-boreal habitats, or occurring in the Pacific Northwest **33**

33. Thallus white with a distinctly yellow or orange hue (dibenzofurans present); Pacific Northwest .... ***Lepraria diffusa***
33. Thallus greenish to blue-gray, without a distinctly yellow or orange hue (stictic acid, atranorin, and zeorin present); widespread in montane or northern-boreal habitats .... ***Lepraria elobata*** **s. str.**

32. Species of temperate habitats (typically middle to low elevations), not occurring the Pacific Northwest **34**

34. Thallus with a distinctive light blue color, resembling soredia in *Fuscopannaria*; pannarin and zeorin present; widespread in eastern and western North America .... ***Leprocaulon adhaerens***
34. Thallus with a distinctive emerald to greenish color, not resembling soredia in *Fuscopannaria*; argopsin present; southern California extending northward at low elevations of the Sierra Nevadas................. .... ***Leprocaulon santamonicae***

16. Thallus P- or P+ yellow **35**

35. Thallus K+ yellow turning red (norstictic or salazinic acid present) **36**

36. Thallus K+ yellow turning red, producing crystals when reaction is performed in a water mount under the compound microscope (norstictic acid present) ..... ***Lepraria neglecta* (norstictic acid chemotype)**

36. Thallus K+ yellow turning red, not producing crystals when reaction is performed in a water mount under the compound microscope (salazinic acid present) ..... ***Lepraria elobata* (salazinic acid chemotype)**

35. Thallus K- or K+ yellowish (other substances present) **37**

37. Thallus placodioid-type **38**

38. Coastal soil communities in western North America; thallus *xerophila*-type, with a "crisped" lip at the margin ..... ***Lepraria xerophila***

38. Eastern North America; thallus *finkii*-type, without a "crisped" lip at the margin ..... ***Lepraria harrisiana***

37. Thallus aggregate-type **39**

39. Granules compact, with a pseudocortex; in exposed habitats ..... ***Lepraria neglecta* (psoromic, fatty acid, porphyrilic acid chemotypes)**

39. Granules fluffy, without a well-developed pseudocortex; in sheltered or protected habitats **40**

40. Granules with abundant, long projecting hyphae at maturity; nephrosteranic acid present ..... ***Lepraria rigidula***

40. Granules without abundant, long projecting hyphae at maturity; other substances present ..... **41 (TLC required; compare specimen to images in the treatment)**

41. Zeorin present ..... ***Lepraria caesiella***

41. Zeorin absent **42**

42. Roccellic/angardianic acid present in addition to rangiformic/jackinic acid ..... ***Lepraria jackii***

42. Roccellic/angardianic acid absent, rangiformic/jackinic acid present ..... ***Lepraria humida***

ACCOUNTS OF THE SPECIES

1) *Lepraria aurescens* Orange & Wolseley, Lichenologist 37: 247. 2005. TYPE: **THAILAND. CHIANG MAI PROV.:** Dio Suthep, transect Wat Palad, alt. 680 m, dry evergreen forest, 25.xi.1991, on bark, *P.A. Wolseley & B. Aguirre-Hudson 5001* (BM [n.v.], holotype).

FIGURES 2 AND 3.

Description. – **Thallus** crustose, leprose, placodioid, continuous and typically distinctly bi-layered, initially forming small discrete thalli which expand marginally, overlap and become confluent to form a thick crust (0.2–0.4 mm thick), light gray-blue in color; **hyphae** hyaline, [1.6]–(2.3)–2.8–(3.4)–[4.8] µm (*n*=64) in width, septate, secund, obscured by a thick layer of POL+ crystals that do not dissolve in KOH; **prothallus** disappearing with age; **hypothallus** a thin, often poorly developed layer of loosely intertwined hyphae surrounding and subtending the granules, extending outward from the edge of the thallus; **rhizohyphae** present, pale to dirty brownish; **granules** globose, [26]–(36)–45–(54)–[72] µm (*n*=126) in diameter, ecorticate, well organized and discrete, often forming compound units of multiple granules; **photobiont** green, coccoid, cells globose, [6]–(7.5)–9.2–(10.8)–[14.6] µm (*n*=135) in diameter.

Chemistry. – Thamnolic acid. Spot tests: K+ lemon yellow, C-, KC-, P+ orange, UV-.

Ecology and distribution. – *Lepraria aurescens* is essentially restricted to tropical and subtropical Florida in North America (figure 3). The species was originally described from Thailand and may be

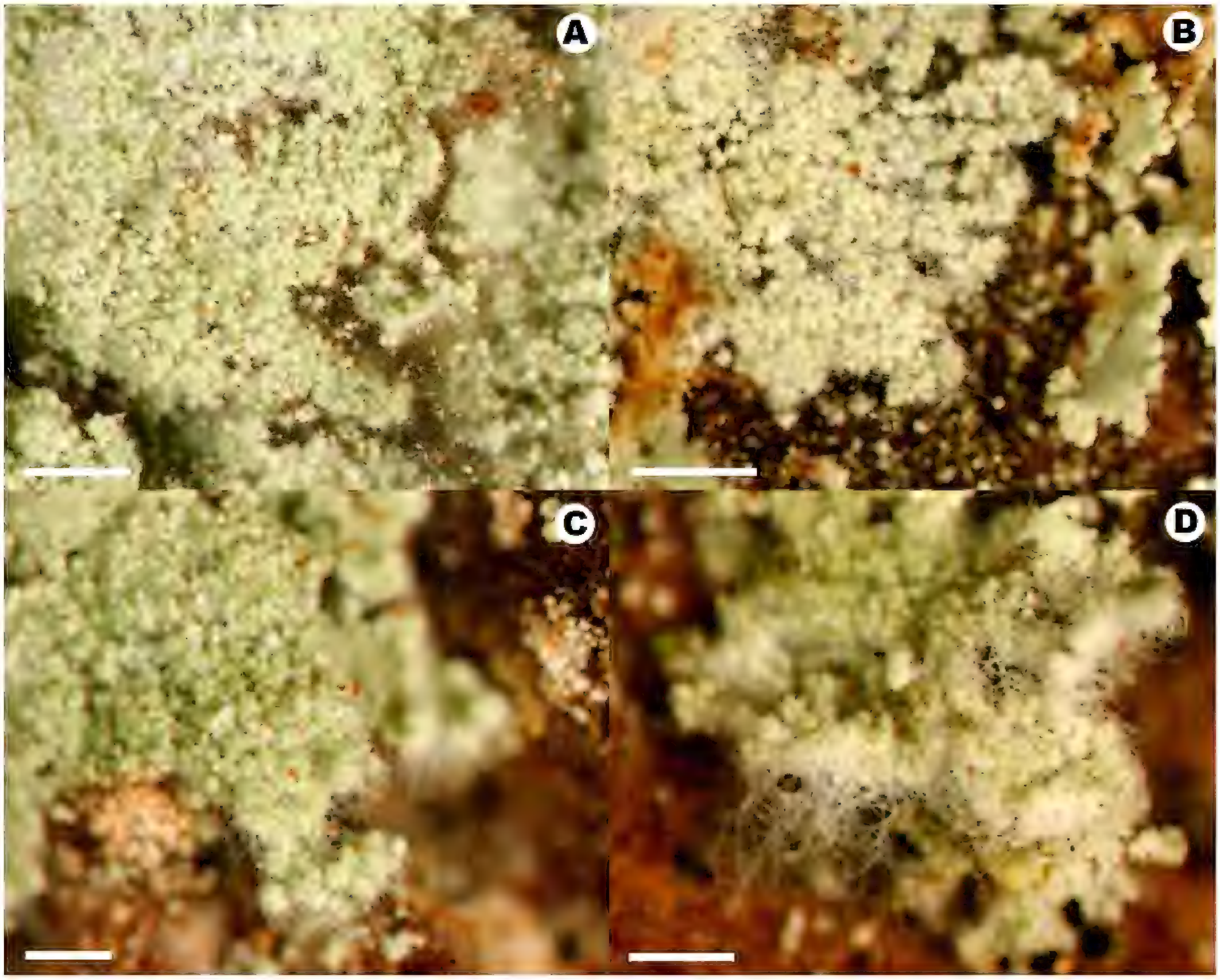

Figure 2, *Lepraria aurescens*. A, thallus surface, and edge with dark rhizohyphae (*Lendemer 15843A*, scale = 0.5 mm). B, thallus surface and edge with pale rhizohyphae (*Harris 39672*, scale = 0.5 mm). C, detail of thallus surface and edge (*Lendemer 15843A*, scale = 0.25 mm). D, detail of thallus with upturned margins and pale rhizohyphae (*Harris 39672*, scale = 0.25 mm).

widespread in tropical regions of the world (Orange & Wolseley 2005). In North America the species typically occurs on conifers (*Chamaecyparis* and *Taxodium*) and trunks of old Sabal Palms (*Sabal palmetto* L.). Rarely the species occurs on the bark of hardwood trees (*Quercus*).

Conservation status. – Despite its geographically restricted distribution in North America, this species is not likely currently threatened.

Discussion. – *Lepraria aurescens* is not likely to be confused with any other North American species of *Lepraria* because none is known to produce thamnolic acid as a secondary metabolite. Confusion with *L. squamatica* is possible, as both species have thin placodioid thalli, are partially sympatric, and can occur as mixed populations. Both species also have similar spot test reactions with P because *L. squamatica* produces both baeomycesic and protocetraric acids in addition to squamatic acid. The best way to distinguish the species is to examine material with a long wave UV light: the squamatic acid produced in *L. squamatica* will fluoresce bright white while the thalli of *L. aurescens* will not fluoresce at all. *Lepraria harrisiana* is also morphologically similar to *L. aurescens*, although the geographic distribution of that species is largely allopatric and it produces atranorin, zeorin, and pallidic acid rather than thamnolic acid. Forms of *L. friabilis* in which the aggregate thalli form a continuous crust could also be confused with *L. aurescens*. It differs in being restricted to the bark of conifers and in producing only fumarprotocetraric acid.

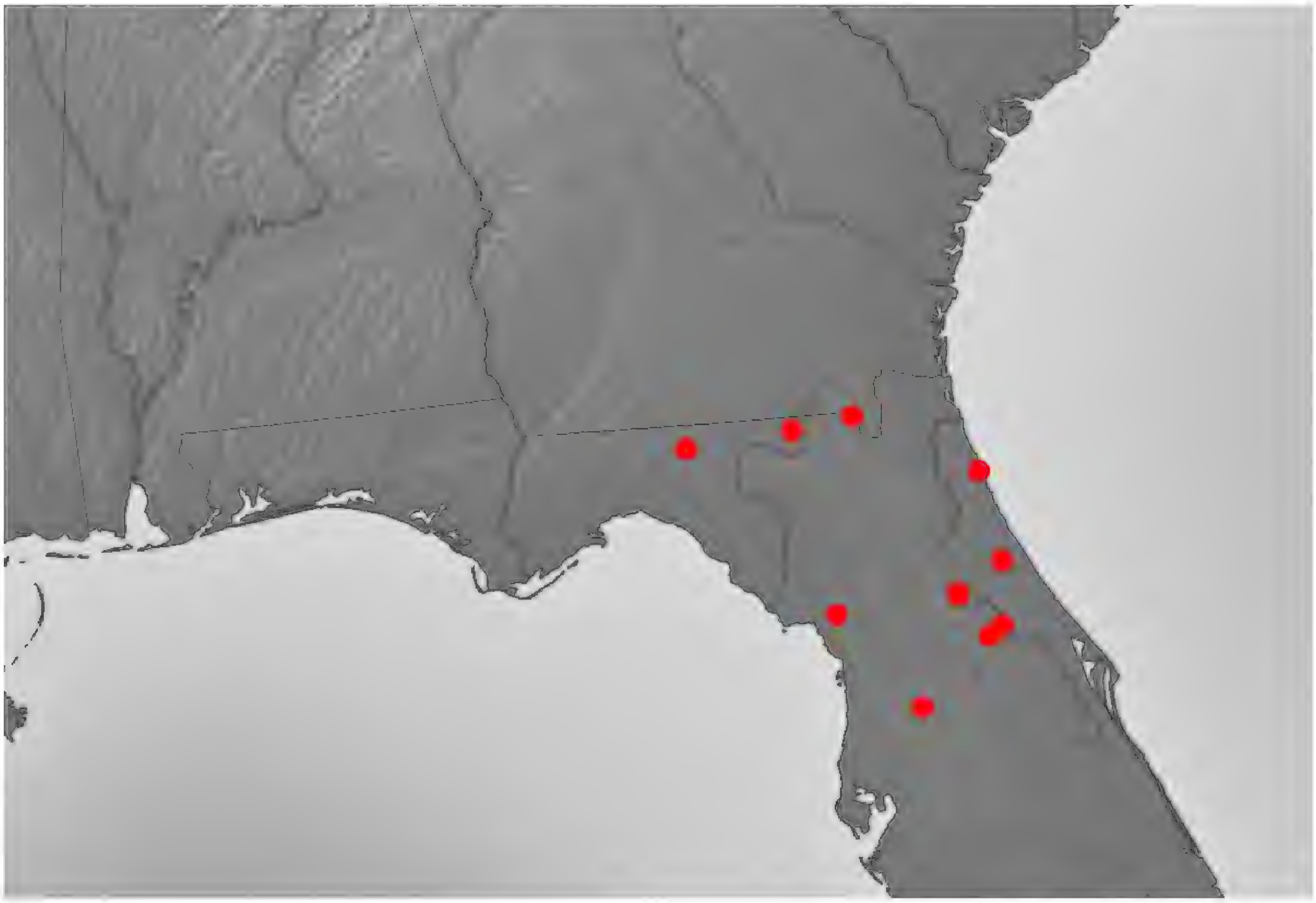

Figure 3, geographic distribution of *Lepraria aurescens* based on the specimens examined for this study.

While reviewing *Lepraria* specimens for this revision, the author occasionally encountered specimens of *Cladonia ravenelii* Tuck. that had been misidentified because the squamulose thallus in that species had nearly completely dissolved into a sorediate crust. Since *C. ravenelii* produces thamnolic acid, such specimens could be misidentified as *L. aurescens*. If one keys a specimen as *L. aurescens* from outside of the geographic region reported here, he or she should carefully confirm that it does not represent *C. ravenelii*. Typically, if the collection is ample, a diligent search will reveal the presence of some partially intact squamules. The placodioid thallus of *L. aurescens*, which possesses a thin hypothallus, is also fundamentally different from the sorediate crust formed in *C. ravenelii*.

Selected specimens Examined (13 total seen from North America). – **U.S.A. FLORIDA.** BAKER CO.: along CR 127 at Moccasin Creek, ~2 mi NNW of FL 2 at Baxter, 26.xi.1996, on *Taxodium*, *R.C. Harris 39321* (NY). FLAGLER CO.: along CR 304 at Sweetwater Creek, 6.i.1996, on *Taxodium*, *R.C. Harris 37406* (NY). HAMILTON CO.: Bee Haven Bay, N of CR 6, 15.xii.1993, on *Taxodium*, *W.R. Buck 24955* (NY). HERNANDO CO.: Withlacoochee State Forest, Richloam Wildlife Management Area, 4.xii.1992, on *Taxodium*, *R.C. Harris 29783* (NY). LAKE CO.: Seminole State Forest, along Atula Rd. from Cassia Trail head S of Brantley Branch Rd., 8.iii.2009, on *Quercus*, *J.C. Lendemer 15843-A & W.R. Buck* (NY). LEVY CO.: Goethe State Forest, Sand Slough, 4.xii.1996, at base of *Taxodium*, *R.C. Harris 39672* (NY). MADISON CO.: E of CR 150 at Little Aucilla River, 14.xii.1993, on *Taxodium*, *R.C. Harris 32443* (NY). MARION CO.: Ocala National Forest, 2.2 mi N of SR 40 on SR 19, Mormon Branch, 2.i.1996, on *Chamaecyparis*, *R.C. Harris 37201* (NY). ST. JOHNS CO.: South Ponte Vedra Beach, Guana Tolomato Matanzas National Estuarine Research Reserve, 28.xi.2008, on *Quercus*, *W.R. Buck 54370* (NY). VOLUSIA CO.: Blue Spring State Park, 23.iii.1998, on lower side of slanting burnt *Sabal*, *R.C. Harris 41493* (NY). WAKULLA CO.: Apalachicola National Forest, along FS Rd. 3.9 at Lost Creek, 4.xii.1988, on *Taxodium*, *R.C. Harris 23389* (NY).

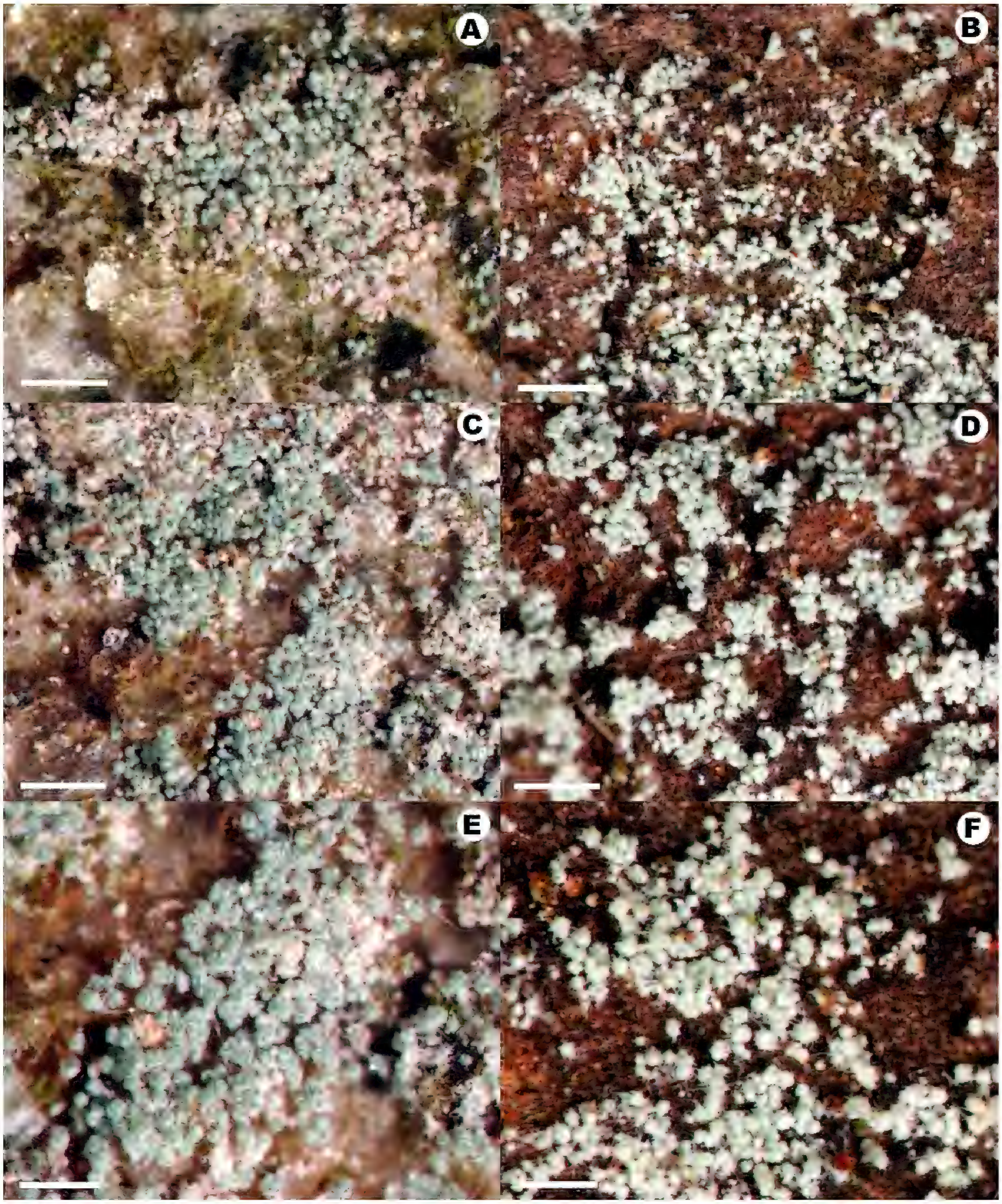

Figure 4, *Lepraria caesiella*, comparison of saxicolous population (all from *Lendemer 27454*) and corticolous population (all from *Lendemer 26684*). A–D, gross morphology of the thallus (scales = 0.5 mm). E–F, detail of the granules (scales = 0.25 mm).

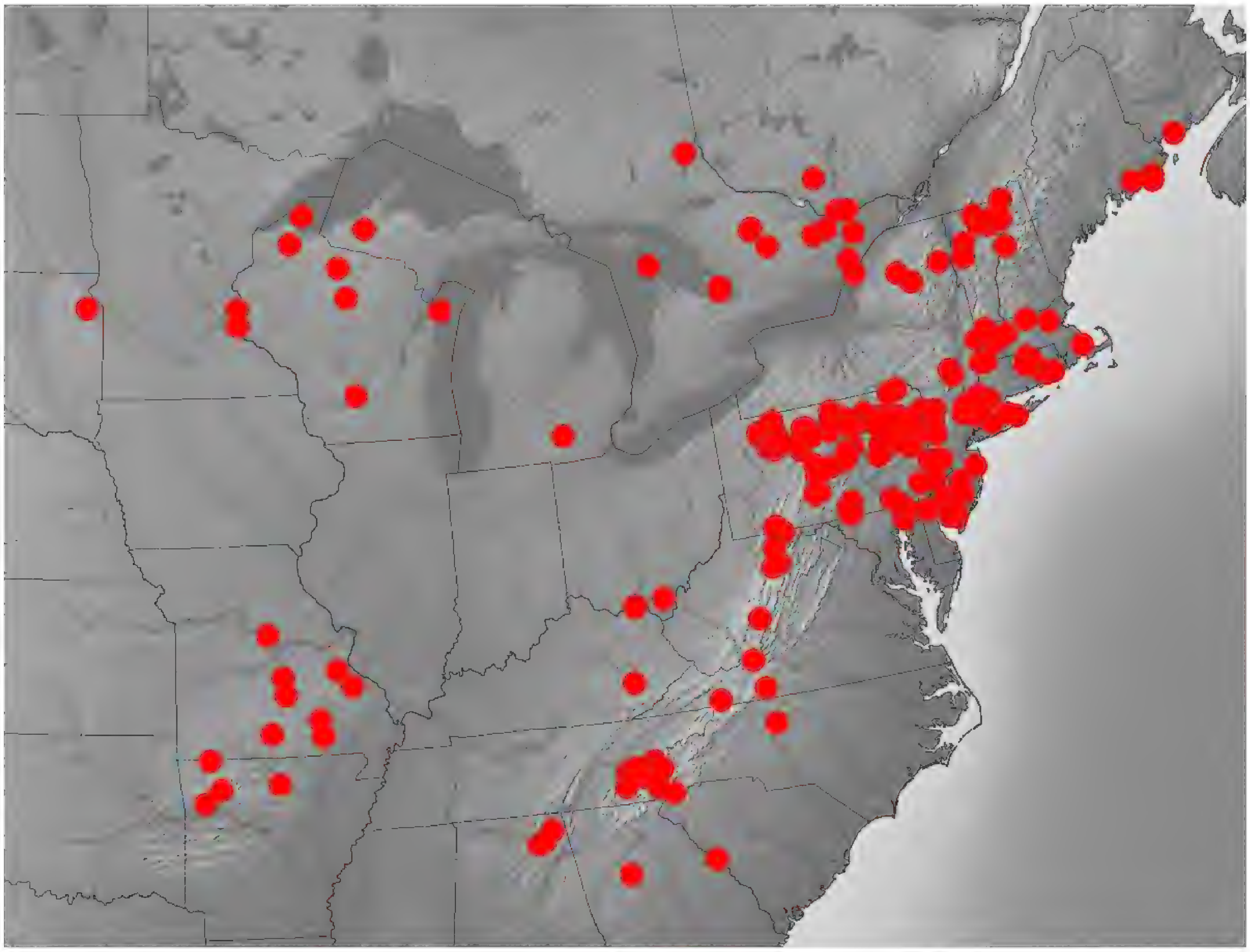

Figure 5, geographic distribution of *Lepraria caesiella* based on the specimens examined for this study.

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2) ***Lepraria caesiella*** **R.C. Harris** *in* Lendemer, Opuscula Philolichenum 2: 51. 2005. TYPE: **U.S.A. PENNSYLVANIA.** MONROE CO.: Delaware Water Gap National Recreation Area, Community Drive Wetlands, ca. 1 mi S of Shoemakers, ca. 2 mi S of Bushkill, 24.iv.2004, on large dead birch (*Betula*), *Lendemer et al. 2304 = Lich. East. N. Amer. Exs. IV: 172* (NY!, holotype; ASU!, B!, BG!, DOV!, FH!, GZU!, H!, MIN!, NDA!, S!, TU!, isotypes).

FIGURES 4 AND 5.

Description. – **Thallus** crustose, leprose, aggregated, discontinuous and not stratified, initially composed of isolated granules that divide to form aggregations, eventually merging to form a thin crust (<0.1 mm thick), gray-blue in color; **hyphae** hyaline, [1.8]–(2.4)–3.1–(3.7)–[5] µm (*n*=42) in width, septate, secund, obscured by a thick layer of POL+ crystals that dissolve in KOH and recrystallize as thin bent needles; **prothallus** persistent; **hypothallus** absent; **rhizohyphae** absent; **granules** globose, [24]–(35)–47–(59)–[76] µm (*n*=96) in diameter, ecorticate, well organized and discrete, remaining distinct and not forming compound units; **photobiont** green, coccoid, cells globose, [6]–(7.9)–9.8–(11.8)–[15.6] µm (*n*=96) in width.

Chemistry. – Atranorin, zeorin, pallidic acid. Spot tests: K+ yellow, C-, KC-, P+ weak yellow, UV-.

Ecology and distribution. – *Lepraria caesiella* is common and widely distributed throughout temperate and boreal northeastern North America, extending southward in the Appalachian Mountains (fig. 5). Disjunct saxicolous populations also occur in the Ozark Ecoregion. The species occurs on a wide diversity of corticolous substrates, including both conifers and hardwoods. Though the majority of the corticolous collections examined are from hardwoods, particularly oaks (*Quercus*), saxicolous populations are also often encountered on non-calcareous rocks. These saxicolous populations are ecologically distinct from other sympatric *Lepraria* species with aggregate thalli because they occur on dry, protected rock faces that are sheltered from rain but still exposed to some light. Most other species occur either on rock faces fully exposed to the elements, or in shaded overhangs that are completely protected and always shaded.

Conservation status. – This species is common and widely distributed in temperate eastern North America and does not likely warrant conservation consideration. It is often found in second or third growth forests in areas where the lichen biota has been significantly negatively impacted by past anthropogenic disturbance.

Discussion. – *Lepraria caesiella* is chemically comparable to *L. harrisiana* in producing atranorin, zeorin, and pallidic acid, but that species differs morphologically in having a *cryophila*-type placodioid thallus. Although previously considered conspecific, the two entities are strongly supported as distinct in molecular phylogenetic analyses of nuITS sequence data (Lendemer 2012a). Of the six other species of *Lepraria* with aggregate thalli in North America, only *L. elobata* and *L. neglecta* are likely to be confused with *L. caesiella*. The former species produces salazinic acid or stictic acid in addition to atranorin and zeorin, and does not produce pallidic acid. The latter species is extremely variable chemically (see the account for that species) and only the rare chemotype with zeorin and stictic acid could be confused with *L. caesiella*. That chemotype of *L. neglecta* differs chemically from *L. caesiella* in producing stictic acid, and morphologically from *L. caesiella* in having granules that produce a distinct pseudocortex at maturity. *Lepraria humida* Slav.-Bay. & Orange is a saxicolous species of shaded overhangs that was described from Europe and is widespread in the Appalachian Mountains of eastern North America. That species produces rangiformic/jackinic acid and does not produce zeorin. It is also much rarer than *L. caesiella*.

The lichen that has most often been confused with *Lepraria caesiella* is actually *Lecanora nothocaesiella* Lendemer & R.C. Harris. That species is a sorediate member of the *Lecanora subfusca* group with *allophana*-type apothecia. The species differs from *L. caesiella* in lacking pallidic acid and in not having a truly leprose thallus. Rather, the thallus in *L. nothocaesiella* only appears superficially leprose because it produces diffuse eroding soralia that are immersed in the substrate. It also typically produces a conspicuous, shiny, film-like prothallus with darkened areas near the growing edge of the thallus. Species of *Lepraria* never produce this type of prothallus because the hyphae of the thallus rest on, rather than penetrate and grow through, the substrate (Lendemer 2011a).

Selected specimens examined (329 total seen from North America). – **CANADA. NEW BRUNSWICK.** CHARLOTTE CO.: Pennfield Parish, W of Jake Lee Rd., 1.v.2011, on *Betula*, *J.C. Lendemer 28023-A* (NY). **ONTARIO.** BRUCE CO.: Bruce Peninsula National Park, 19.ix.2008, on dead *Picea*, *R.C. Harris 54884* (NY). LANARK CO.: 0–0.2 mi N of Peneshula Rd., 0.6 mi W of jct. w/ Cedar Cove Rd., 21.v.2011, on *Pinus*, *J.C. Lendemer 28196 & R.E. Lee* (NY). **QUEBEC.** GATINEAU CO.: Gatineau Park, near Ramsey Lake, 30.vii.1978, on *Tsuga*, *T. Ahti 34648 & I.M. Brodo* (H, NY). LES COLLINES DE L'OUTAOUAIS CO.: 6.1 km NW of Chelsea, 7.vi.2009, on stump, *I.M. Brodo 32422 & C. Freebury* (NY). PONTIAC MNP.: Gatineau Park, Church Hill, 22.v.2011, on *Tsuga*, *J.C. Lendemer 28332 & C. Freebury* (NY). **U.S.A. ARKANSAS.** FRANKLIN CO.: Ozark National Forest, Boston Mountains Ranger District, Shores Lake, 17.x.2005, on sandstone, *J.C. Lendemer 5605* (NY). **CONNECTICUT.** LITCHFIELD CO.: Town of Norfolk, Holleran Swamp Preserve, 20.ix.2003, on *Acer*, *R.C. Harris 48065* (NY). WINDHAM CO.: Town of Westford, Yale Myers Forest, Boston Hollow, 19.ix.2009, on *Tsuga*, *R.C. Harris 55660* (NY). **DELAWARE.** SUSSEX CO.: Ellendale State Forest, 25.x.1989, on *Ilex*, *R.C. Harris 24913* (NY). **KENTUCKY.** PERRY CO.: Daniel Boone National Forest, Old Field Branch of Leatherwood Creek, 6.x.2001, on *Tsuga*, *R.C. Harris 44971* (NY). **MAINE.** YORK CO.: Town of Saco, Ferry Beach State Park, 15.ix.2002, on *Betula*, *R.C. Harris 46335* (NY). **MARYLAND.** CECIL CO.: Elk Neck State Forest, Black Hill Tract, 30.xi.2009, on *Quercus*, *J.C. Lendemer 19967* (NY). **MASSACHUSETTS.** BERKSHIRE CO.: Town of Hancock, Pittsfield State Forest, 4.vi.2010, on *Acer*, *J.C. Lendemer 22492* (NY). FRANKLIN CO.: Leverett, 8.viii.1963, on *Quercus*, *W. Hutchinson 600* (NY). MIDDLESEX CO.: Estabrook Woods, Concord, 31.v.1978, on *Quercus*, *M.A. Sherwood s.n.* (FH). PLYMOUTH CO.: Town of Carver, Myles Standish State Forest, 31.vii.2010, on *Picea*, *W.R. Buck 56448* (NY). **MICHIGAN.** JACKSON CO.: E of Updike Rd., ~.4 mi N of I-94, 25.vi.1979, on *Quercus*, *R.C. Harris 13098* (NY). ONTONAGON CO.: Ottawa National Forest, Lathrop Creek, 10.viii.2003, on *Tsuga*, *C.M. Wetmore 89965* (MIN, NY). **NEW JERSEY.** ATLANTIC CO.: Wharton State Forest, N of Pleasant Mills Cemetery, 24.x.2004, on *Sassafras*, *J.C. Lendemer 3355* (NY). BURLINGTON CO.: Wharton State Forest, Batsto Natural Area, 9.x.2004, on *Quercus*, *J.C. Lendemer 3181* (NY). CAMDEN CO.: Wharton State Forest, 0–0.5 mi W of CR 536 (Chew Rd.), 6.ii.2009, on *Quercus*, *J.C. Lendemer 15487* (NY). CUMBERLAND CO.: Peaslee Wildlife Management Area, 2.ii.2009, on *Quercus*, *J.C. Lendemer 15095* (NY). GLOUCESTER CO.: Winslow Wildlife Management Area, 6.ii.2009, on *Pinus*, *J.C. Lendemer 15441* (NY). HUNTERDON CO.: Mitchell property, 4.xi.1992, on *Crataegus*, *R.C. Harris 28993* (NY). MONMOUTH CO.: Allaire State Park, 5.ii.2009, on *Quercus*, *J.C. Lendemer 15417* (NY). OCEAN CO.: Manahawkin Wildlife Management Area, 2.xii.2009, on *Quercus*, *J.C. Lendemer 20067* (NY). SALEM CO.: Parvin State Park, 26.xii.2008, on *Quercus*, *J.C. Lendemer et al. 15012* (NY). WARREN CO.: Jenny Jump State Forest, 11.ix.1992, on *Tsuga*, *R.C. Harris 27924* (NY). **NEW YORK.** ESSEX CO.: SW side of Chapel Pond, 19.ix.2004, on *Acer*, *J.C. Lendemer 3093* (NY). JEFFERSON CO.: Wellesley Island State Park, 20.ix.1983, on *Tsuga*, *R.C. Harris 16751* (NY). SUFFOLK CO.: 1.5 km W of Promised Land, 22.iv.1984, on *Pinus*, *R.C. Harris 17967* (NY). ST. LAWRENCE CO.: J.F. Dubuar Forest Trail, 6.ix.1981, on dead *Picea*, *R.C. Harris 13971* (NY). ULSTER CO.: along Esopus Creek, 13.ix.1980, on *Pinus*, *R.C. Harris 13460* (NY). WESTCHESTER CO.: Mianus Gorge, 14.viii.1976, on bark, *C.R. Prince 76-48* (NY). **NORTH CAROLINA.** FORSYTH CO.: Winston-Salem, 15.viii.1955, on *Acer*, *P. Schallert s.n.* (COLO). GRAHAM CO.: Nantahala National Forest, Hooper Bald, 1.x.1997, on *Betula*, *R.C. Harris 41064* (NY). SWAIN CO.: Great Smoky Mountains National Park, terminus of Lakeshore Drive to jct. of Lakeshore Trail and White Oak Branch Trail, 29.vi.2010, on *Pinus*, *J.C. Lendemer et al. 23421* (NY). TRANSYLVANIA CO.: Gorges State Park, 12.viii.2005, on *Betula*, *J.C. Lendemer 4958 & E. Tripp* (NY). **OHIO.** GALLIA CO.: Wayne National Forest, Symmes Creek Natural Area, 19.v.2006, on *Quercus*, *R.C. Harris 52648* (NY). SCIOTO CO.: Shawnee National Forest, above Turkey Creek Lake, 18.v.2006, on *Acer*, *J.C. Lendemer 7525* (NY). **PENNSYLVANIA.** CLARION CO.: Cook Forest State Park, 6.ix.2010, on *Tsuga*, *J.C. Lendemer 24542* (NY). ELK CO.: Moshannon State Forest, Barr Hollow, 31.viii.2010, on rock, *J.C. Lendemer 23974* (NY). FRANKLIN CO.: Michaux State Forest, N-slopes of Rocky Mountain, 1.vi.2009, on *Quercus*, *J.C. Lendemer 18206* (NY). MONROE CO.: Tannersville Bog TNC Preserve, 24.xi.2009, on *Tsuga*, *J.C. Lendemer 19940-A & V. Doyle* (NY). NORTHUMBERLAND CO.: Wildlife Preserve, ~2.5 mi W of Alaska, 20.v.2009, on *Quercus*, *R.C. Harris 55331* (NY). PHILADELPHIA CO.: Fairmount Park, Forbidden Drive, 3.iii.2007, on *Acer*, *J.C. Lendemer 8603 & A. Moroz* (NY). SULLIVAN CO.: Ricketts Glen State Park, 19.ix.2010, on *Tsuga*, *J.C. Lendemer 25661 & J. Kunsman* (NY). TIOGA CO.: Tioga State Forest, Asaph Wild Area, 11.v.2009, on *Tsuga*, *J.C. Lendemer 16435 & D. Atha* (NY). UNION CO.: Bald Eagle State Park, Joyce Kilmer Natural Area, 14.ix.2010, on *Tsuga*, *J.C. Lendemer 25411* (NY). YORK CO.: Apollo County Park, 9.xiii.2009, on *Betula*, *J.C. Lendemer 19429* (NY). **RHODE ISLAND.** WASHINGTON CO.: Marion Eppley Wildlife Sanctuary, 16.ix.2006, on *Nyssa*, *R.C. Harris 53142* (NY). **TENNESSEE.** BLOUNT CO.: Great Smoky Mountains National Park, White Oak Sinks, 13.x.2010, on *Tsuga*, *J.C. Lendemer et al. 26884* (NY). COCKE CO.: Great Smoky Mountains National Park, Gabes Mountain Trail, 5.viii.2009, on *Tsuga*, *J.C. Lendemer 19034 & E. Tripp* (NY). **VERMONT.** ADDISON CO.: Green Mountain National Forest, Bristol Cliffs Wilderness Area, 20.x.2010, on *Betula*, *J.C. Lendemer 27367 & M. Sundue* (NY). CALEDONIA CO.: Town of Wheelock, Wheelock Farm, 22.x.2010, on *Abies*, *J.C. Lendemer 27547 & M. Sundue* (NY). CHITTENDEN CO.: Town of Huntington, Lower Gorge Preserve, 17.x.2010, on *Tsuga*, *J.C. Lendemer 27089 & M. Sundue* (NY). ESSEX CO.: Town of Averill, Quimby Country resort property, 19.v.2008, on *Betula*, *R.C. Harris 54586* (NY). ORLEANS CO.: Town of Craftsbury, Craftsbury Outdoor Center, 16.v.2005, on *Abies*, *R.C. Harris 51478* (NY). **VIRGINIA.** GILES CO.: Pond Drain, 7.x.1995, on *Betula*, *R.C. Harris 36700* (NY). PATRICK CO.: Blue Ridge Parkway, Rock Castle Gorge Loop Trail, 6.x.1995, on *Quercus*, *R.C. Harris 36648* (NY). **WEST VIRGINIA.** PRESTON CO.: 2 mi N of Terra Alta, 287.vi.1963, on trees, *C.F. Reed 62858* (NY). POCAHONTAS CO.: Watoga State Park, 30.ix.2000, on *Tsuga*, *R.C. Harris 43932* (NY). TUCKER CO.: Monongahela National Forest, Olsen's Bog, 22.iv.2001, on *Betula*, *R.C. Harris 44871* (NY). **WISCONSIN.** BAYFIELD CO.: Chequamegon National Forest, Rainbow Lake, 29.v.2004, on *Tsuga*, *C.M. Wetmore 90460* (MIN, NY). ONEIDA CO.: Town of Minocqua, Patterson Hemlocks State Natural Area, 29.iv.2002, on *Tsuga*, *R.C. Harris 45977* (NY).

3) *Lepraria cryophila* Lendemer, Brittonia 62: 275. 2010. TYPE: **U.S.A. NORTH CAROLINA.** HAYWOOD CO.: Great Smoky Mountains National Park, vicinity of Baxter Creek, trail to summit of Mt. Sterling (2 miles to summit), 1370–1760 m, spruce-fir-birch forest with sparse hemlock, on vertical rock face, 26.iv.2008, *J.C. Lendemer et al. 11961* (NY!, holotype).

FIGURES 6–8.

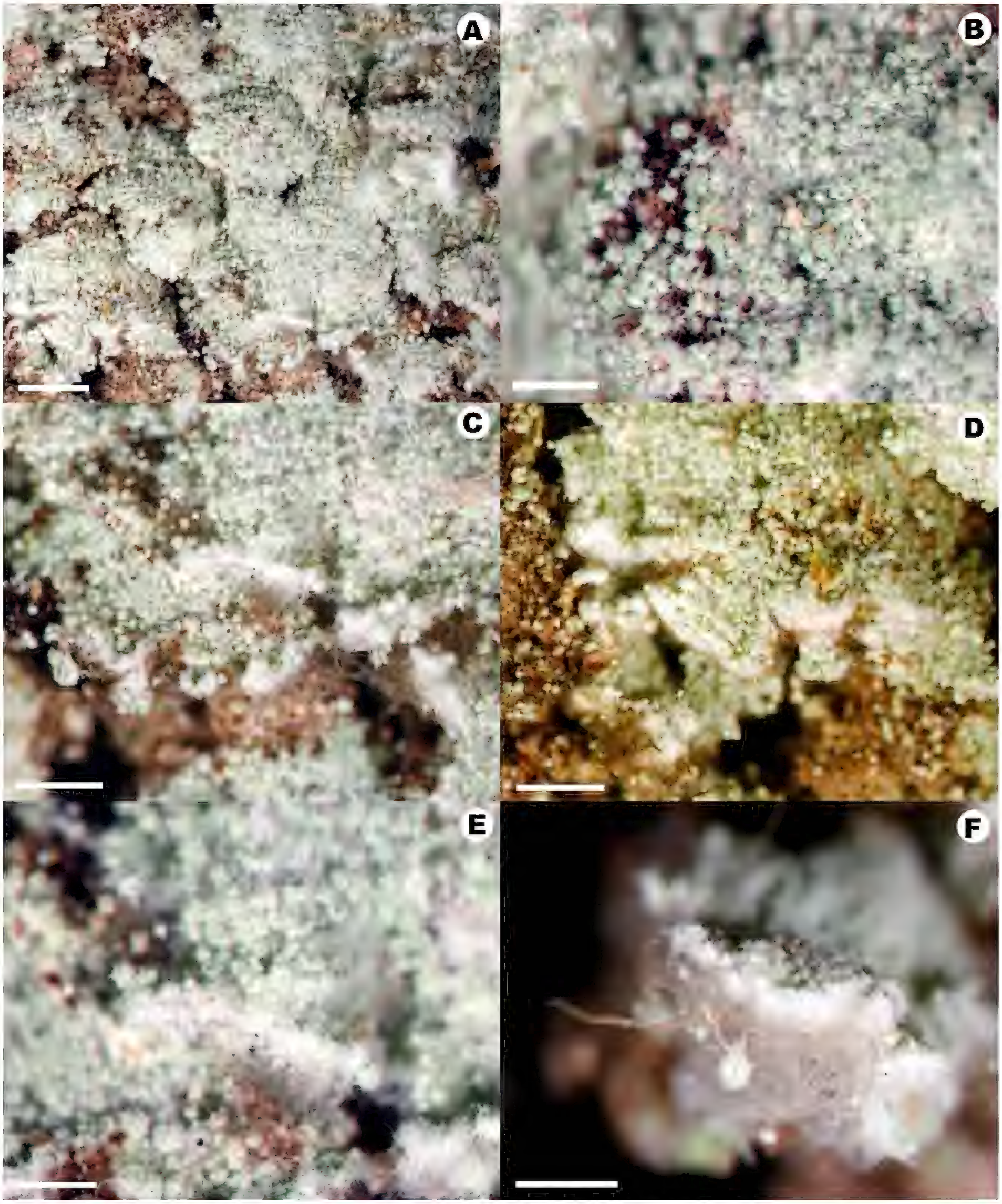

Figure 6, typical population of *Lepraria cryophila* from the Appalachian Mountains (all from *Lendemer 22721*). A, gross morphology of the thallus (scale = 1.0 mm). B, detail of the granules and thallus surface (scale = 0.25 mm). C–D, ascending thallus margins (scale = 0.5 mm). E–F, detail of ascending thallus margins, note the presence of pale rhizohyphae that begin to turn dirty brownish towards the tips (scales = 0.5 mm).

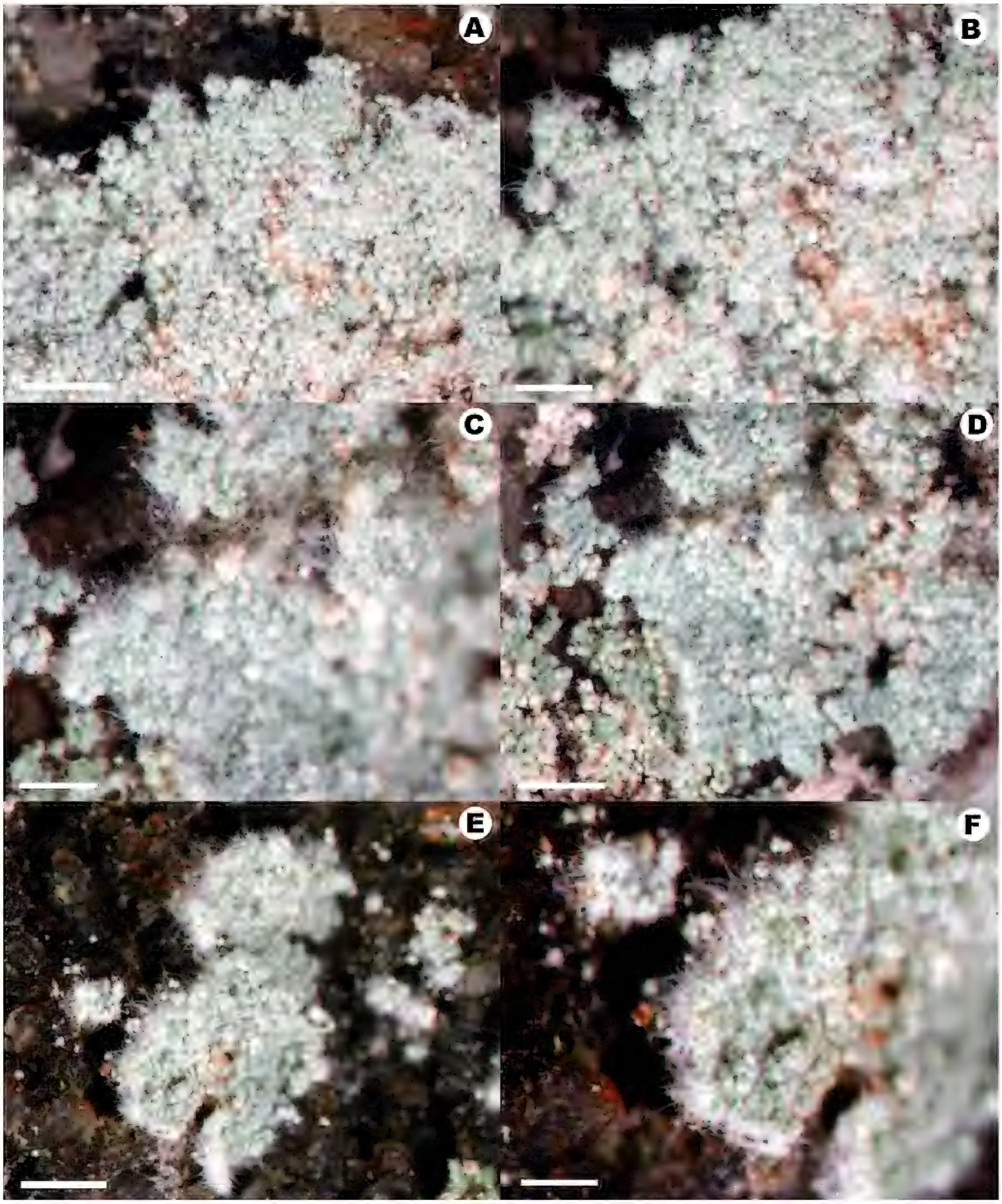

Figure 7, typical population of *Lepraria cryophila* from the Ozark Ecoregion (all from *Lendemer 25898*). A, gross morphology of thallus (scale = 0.5 mm). B, detail of the thallus surface (scale = 0.25 mm). C, detail of thallus margin (scale = 0.25 mm). D, aspect of ascending thallus margins (scale = 0.5 mm). E, young thallus with ascending margins (scale = 0.5 mm). F, detail of thallus margin, not the poorly developed pale rhizohyphae (scale = 0.25 mm).

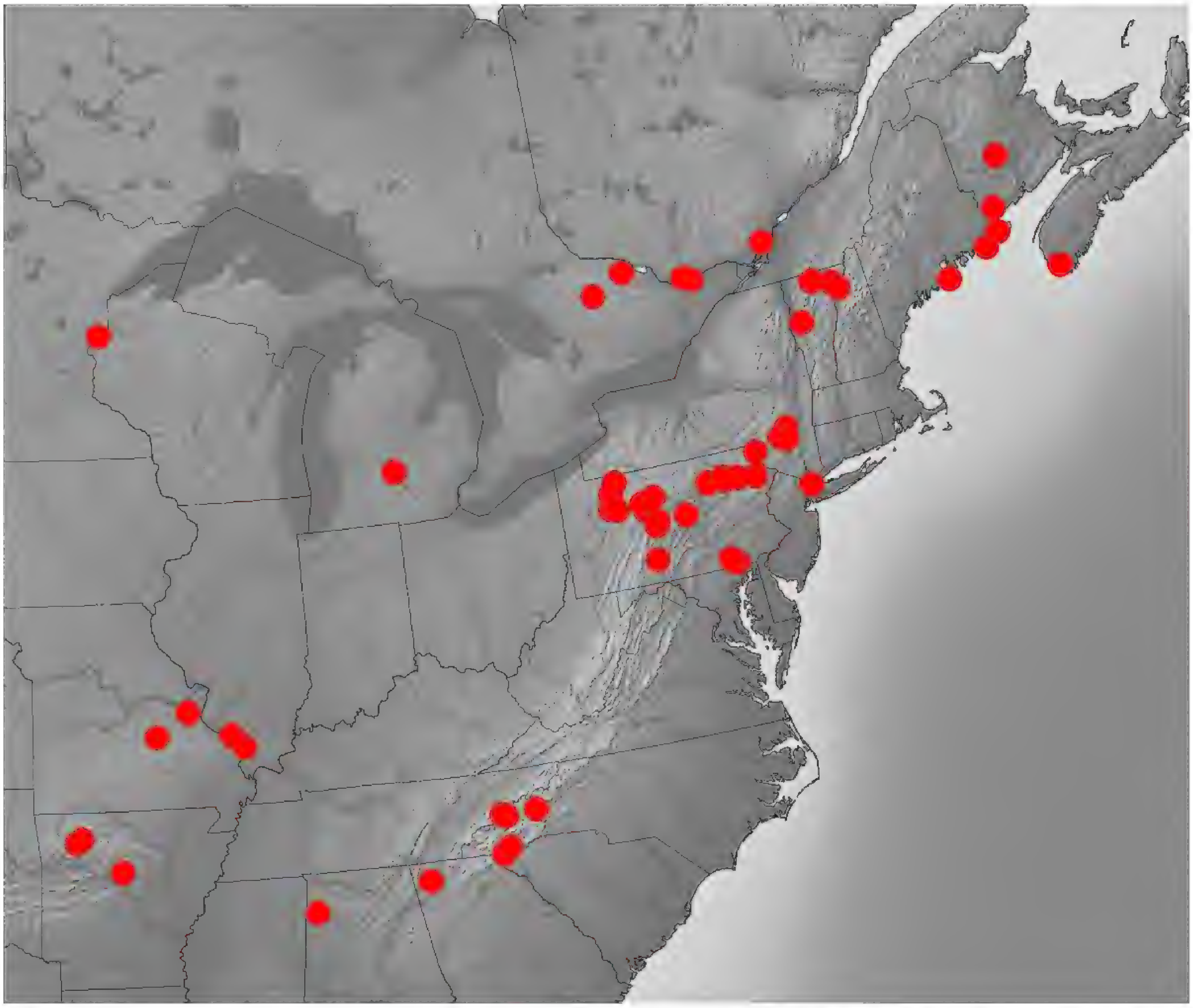

Figure 8, geographic distribution of *Lepraria cryophila* based on the specimens examined for this study.

Description. – **Thallus** crustose, leprose, placodioid, continuous and distinctly bi-layered, initially forming small discrete thalli which expand marginally, overlap and become confluent to form a thick crust (0.2–0.7 mm thick), off white to light blue-white in color; **hyphae** hyaline, [1.4]–(2.2)–2.8–(3.4)–[5] µm (*n*=120) in width, septate, secund, obscured by a thick layer of crystals that dissolve in KOH; **prothallus** disappearing with age; **hypothallus** a well-developed layer of loosely intertwined hyphae surrounding and subtending the granules, extending outward from the edge of the thallus; **rhizohyphae** present, abundant, pale to dirty brownish; **granules** globose, [18]–(24)–30–(37)–[52] µm (*n*=120) in diameter, ecorticate, well organized and discrete, often forming compound units of multiple granules; **photobiont** green, coccoid, cells globose, [5]–(6.3)–8.0–(9.6)–[12.5] µm (*n*=120) in diameter.

Chemistry. – Divaricatic acid, nordivaricatic acid. Spot tests: K-, C+ pink-red, KC+ pink-red, P-, UV+ blue-white.

Ecology and distribution. – *Lepraria cryophila* is a species that typically occurs on non-calcareous rocks in high humidity microhabitats throughout eastern North America and the Ozark Ecoregion (figure 8). Occasional populations have been found on the bases of trees directly adjacent to typical thalli occurring on rock or in habitats with unusually high humidity.

Conservation status. – Although *Lepraria cryophila* is common throughout eastern North America, with disjunct occurrences in the Ozarks and Great Lakes, it may warrant consideration in management practices in some regions. There is also a strong potential for this species to be used as an indicator of other, rarer species that are less conspicuous. The habitats occupied by *L. cryophila* often host populations of rare or disjunct lichens and can be easily damaged by anthropogenic influences (Lendemer et al. 2009).

Discussion. – *Lepraria cryophila* is a distinctive saxicolous species of eastern North America that can readily be recognized by its chemistry (divaricatic acid and nordivaricatic acid in high concentrations) and *cryophila*-type placodioid thallus. Only two other species of North American *Lepraria* produce divaricatic acid, *L. hodkinsoniana* and *L. pacifica*. Both of these differ from *L. cryophila* in having aggregate thalli, and in the production of zeorin as well as the presence of only traces of nordivaricatic acid. *Lepraria finkii* is the species most likely to be confused with *L. cryophila* on account of its placodioid thallus and frequent occurrence in similar habitats. That species differs chemically from *L. cryophila* in producing atranorin, zeorin, and stictic acid, as well as morphologically in having a *finkii*-type thallus with sparse rhizohyphae, adnate margins, and a dense hypothallus. Thalli in populations of *L. cryophila* from the Ozark Ecoregion (figure 7) often appear thinner and more poorly developed than those from the southern Appalachians (figure 6). This difference is likely due to the drier conditions of the Ozarks compared to the southern Appalachians.

Selected specimens examined (96 total seen from North America). – **CANADA. NEW BRUNSWICK.** CHARLOTTE CO.: Saint Patrick Parish, Caughey-Taylor Nature Preserve, 2.v.2011, on rock, in overhang, *J.C. Lendemer 28060* (NY). **ONTARIO:** Algonquin Park, Track and Tower Trail area, 28.iii.2011, on shaded rock, *C. Lewis 565* (NY). **U.S.A. ALABAMA.** MARION CO.: North Fork Creek, on W side of US 43, 4.x.1999, on sandstone, *W.R. Buck 36427* (NY). **ARKANSAS.** MADISON CO.: Kings River Falls Natural Area, 5.x.2010, on rock in overhang, *J.C. Lendemer et al. 25918* (NY). **GEORGIA.** RABUN CO.: Chattahoochee National Forest, Rabun Bald, 20.ix.1996, on rock, under an overhang, *R.C. Harris 38933* (NY). **ILLINOIS.** JACKSON CO.: Shawnee National Forest, Pomona Natural Bridge, 13.x.1993, on *Liriodendron*, *R.C. Harris 31293* (NY). **MAINE.** KNOX CO.: Vinalhaven, Starboard Rock Sanctuary, 15.vi.2010, on rock, in overhang, *J.C. Lendemer 23235* (NY). WASHINGTON CO.: Town of Beals, Great Wass Island, Great Wass Island TNC Preserve, 7.vi.2010, on rock, in overhang, *J.C. Lendemer 22588* (NY). **MISSOURI.** JEFFERSON CO.: Don Robinson Property, Club Moss Hollow, 24.iii.2006, on sandstone ledge, *J.C. Lendemer et al. 5978* (NY). **NEW HAMPSHIRE.** COUNTY UNKNOWN: White Mountains, x.1843, *E. Tuckerman s.n. = Reliq. Tuck. 56p.p.* (NY). **NEW JERSEY.** BERGEN CO.: Palisades, sine date, *C.F. Austin s.n.* (NY). **NEW YORK.** BRONX CO.: New York Botanical Garden, 4.v.1980, on *Tsuga*, *R.C. Harris 13284* (NY). GREENE CO.: Town of Hunter, Catskill Forest Preserve, Stony Clove Notch on W side of NY 214, 13.ix.2008, on moss, in overhang, *J.C. Lendemer 14089* (NY). ULSTER CO.: Town of Shandaken, Catskill Forest Preserve, Slide Mountain Wilderness Area, W slope of Slide Mountain, 13.ix.2008, on rock in overhang, *J.C. Lendemer 14023* (NY). **NORTH CAROLINA.** BUNCOMBE CO.: Craggy Dome Ridge, 14.vi.1986, on protected rock face, *K. Heiman s.n.* (NY). **PENNSYLVANIA.** CENTRE CO.: Bald Eagle State Forest, Stony Run Rd., 0.5 mi N of jct w/ Negro Hollow Rd., 14.ix.2010, on rock, in overhang, *J.C. Lendemer 25545* (NY). ELK CO.: Elk State Forest, E shore of Chase Run, 1.ix.2010, on rock, in overhang, *J.C. Lendemer 24258* (NY). WAYNE CO.: Lacawac Sanctuary, 25.vii.2009, on rock, in overhang, *J.C. Lendemer 18443* (NY). **VERMONT.** ADDISON CO.: Town of Bristol, Green Mountain National Forest, Bristol Cliffs Wilderness, 20.x.2010, on humus, in overhang, *J.C. Lendemer 27392 & M. Sundue* (NY). ORLEANS CO.: Town of Westfield, Long Trail State Forest, Hazen Notch, 21.x.2010, on rock, in overhang, *J.C. Lendemer 27450 & M. Sundue* (NY). **WEST VIRGINIA.** FAYETTE CO.: New River Gorge, vi.2010, on sandstone, *P. Clark N220Q7* (NY). **WISCONSIN.** BURNETT CO.: Upper St. Croix National Scenic Riverway, Governor Knowles State Forest, Sandrock Cliffs Park, 2.xi.1984, on sandstone, *J.P. Schuster 2207* (MIN, NY).

4) *Lepraria diffusa* (J.R. Laundon) Kukwa, Ann. Bot. Fenn. 39: 226. 2002.

Leproloma diffusum J.R. Laundon, Lichenologist 21: 16. 1989. TYPE: **FINLAND:** lääni Oulo, Paltamo, Melalahti, Viilonkallio, 11.x.1959, ad rupeum dolomitcam, *A.J. Huuskonen & L. Heikkinen s.n. = Lichenotheca Fennica No. 1293* (BM!, holotype).

Leproloma diffusum var. *chrysodetoides* J.R. Laundon, Lichenologist 21: 18. 1989. TYPE: **SWEDEN. VÄRMLAND PROV.:** Burtjärn Par., on the western slope of the hill between Trettondetjärnen and Svarttjärnen, 920 m, 8.xi.1977, over mosses on perpendicular rock (greenstone) in a clearing, previously very likely in shaded situation, *L.E. Muhr 598 = Lich. Sel. Exs. Ups. No. 61* (BM [n.v.], holotype; ASU!, BM!, COLO! isotypes).

Lepraria diffusa var. *chrysodetoides* (J.R. Laundon) Kukwa, Ann. Bot. Fenn. 39: 226. 2002.

FIGURES 9–11.

Description. – **Thallus** crustose, leprose, aggregated, discontinuous and not stratified to continuous, initially composed of isolated granules that divide to form aggregations, eventually merging to form a crust of variable thickness (0.1–0.3 mm), yellow-green in color turning dull yellowish in the herbarium; **hyphae** hyaline, [1.4]–(1.9)–2.4–(2.9)–[3.3] µm (n=32) in width, septate, secund, obscured by a thick layer of crystals that do not dissolve in KOH; **prothallus** persistent; **hypothallus** absent; **rhizohyphae** absent; **granules** globose, [26]–(40)–62–(84)–[132] µm (n=32) in diameter, ecorticate, well organized and discrete; **photobiont** green, coccoid, cells globose, [6]–(7.2)–9.2–(11.1)–[13.2] µm (n=32) in diameter.

Chemistry. – Pannaric acid (tr.), oxypannaric acid-2-methylester, unknown dibenzofuran (remaining at origin). Spot tests: K- or K+ dark red to magenta in pigmented portions, C-, KC-, P+ orange, UV-.

Ecology and distribution. – *Lepraria diffusa* is a rare species that is widely distributed throughout the Northern Hemisphere (Laundon 1989). In North America the species appears to be restricted to the Pacific Northwest (figure 11), however, this may be due to the scarcity of collections available from the Canadian Maritime provinces. The species occurs on the bark of hardwood trees as well as on humus, bryophytes, and rocks in sheltered microhabitats.

Conservation status. – At this time I prefer to consider this taxon "data deficient" and in need of further study. It appears to be rare based on the available material, however, more intensive collection efforts are needed to document its geographic range and ecology.

Discussion. – Thalli of *Lepraria diffusa* typically have the same yellowish hue as other dibenzofuran-producing species. Some populations appear to have orange-pigmented granules in patches across in the thallus (see figures 9 and 10). These were treated as *L. diffusa* var. *chrysodetoides*, an infraspecific entity within *L. diffusa*, by some authors (Laundon 1989, Kukwa 2002) until Kukwa (2006) formally merged them based on the conclusion that the pigments were actually high concentrations of dibenzofurans. This synonymy is followed here. A similar phenomenon involving "pigmented" populations occurs in *L. vouauxii* (see the entry for that species for further discussion). Reliable identification of *L. diffusa*, and all other dibenzofuran-producing species of *Lepraria*, requires study with TLC using known standards from reliably determined specimens.

Selected specimens examined (9 total seen from North America; "pigmented" form as indicated). – **CANADA. BRITISH COLUMBIA.** CHOWICHAN VALLEY REGIONAL DISTRICT: Vancouver Island, between Riverbottom Rd. and Cowchian River, 25.v.2010, on *Acer*, *J.C. Lendemer 22344 & A. Moroz* (NY). NEW WESTMINSTER DISTR.: Brackendale, vi.1916, [on organic matter], *J. Macoun s.n.* (FH). QUEEN CHARLOTTE ISLANDS: Graham Island, 4 mi N of Skidegate Mission, 9.vii.1971, on *Alnus, I.M. Brodo 17949* (NY). **ENGLAND:** Stafford, Wetton, 8.vii.1964, on dry-stone wall, *G.A. Matthews 64/7* (NY). **U.S.A. ALASKA:** Washington Bay, Kuiu Island, 20.viii.1947, on moss, *W.J. Eyerdam 440* (NY), 2.x.1949, on sea cliff, *W.J. Eyerdam 809* (COLO, NY). **OREGON.** DOUGLAS CO.: Panther Leap, above Umpqua River, iii.2010, on rock outcrops, *B. McCune 30488* (NY, pigment present). LANE CO.: Fern Creek, Oakredge Rd., 23.v.1937, on rocks, *F.P. Sipe 976* (NY). LINN CO.: near Clear Lake, x.1939, on lava rocks, *F.P. Sipe s.n.* (COLO). **WASHINGTON.** SAN JUAN CO.: Friday Harbor, 29.vi.1906, on rocks, *B. Fink 79* (FH). SNOHOMISH CO.: Mt. Pilchuck, Gold Basin, xii.1947, on ground, *E. Larrison 1040* (NY).

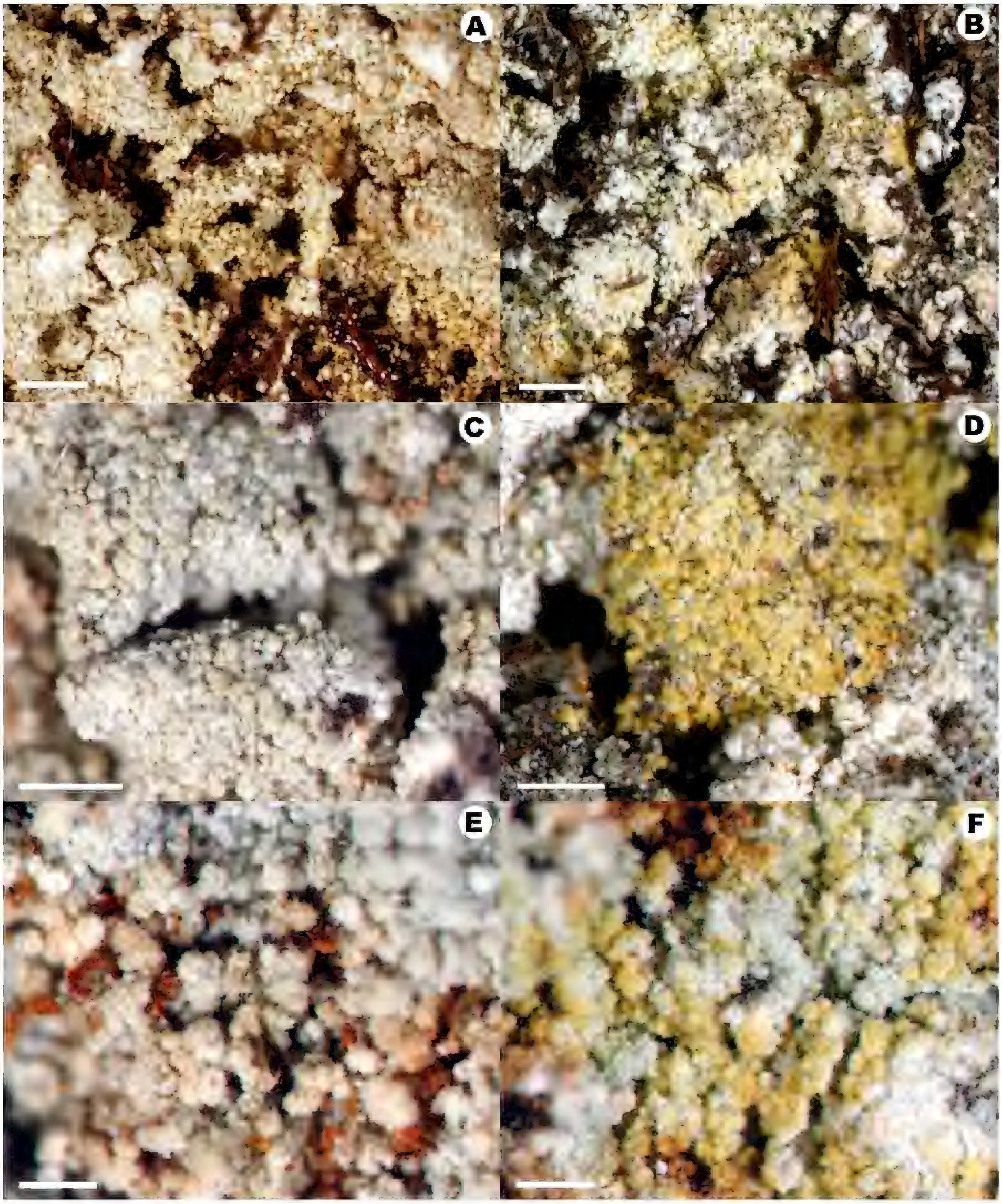

Figure 9, comparison of type specimens of *Lepraria diffusa* (left, from holotype) and *L. diffusa* var. *chrysodetoides* (right, from isotype in BM). A–B, gross morphology of the thallus (scales = 1.0 mm). C–D, thallus surface (scales = 0.5 mm). E–F, detail of the granules (scales = 0.25 mm).

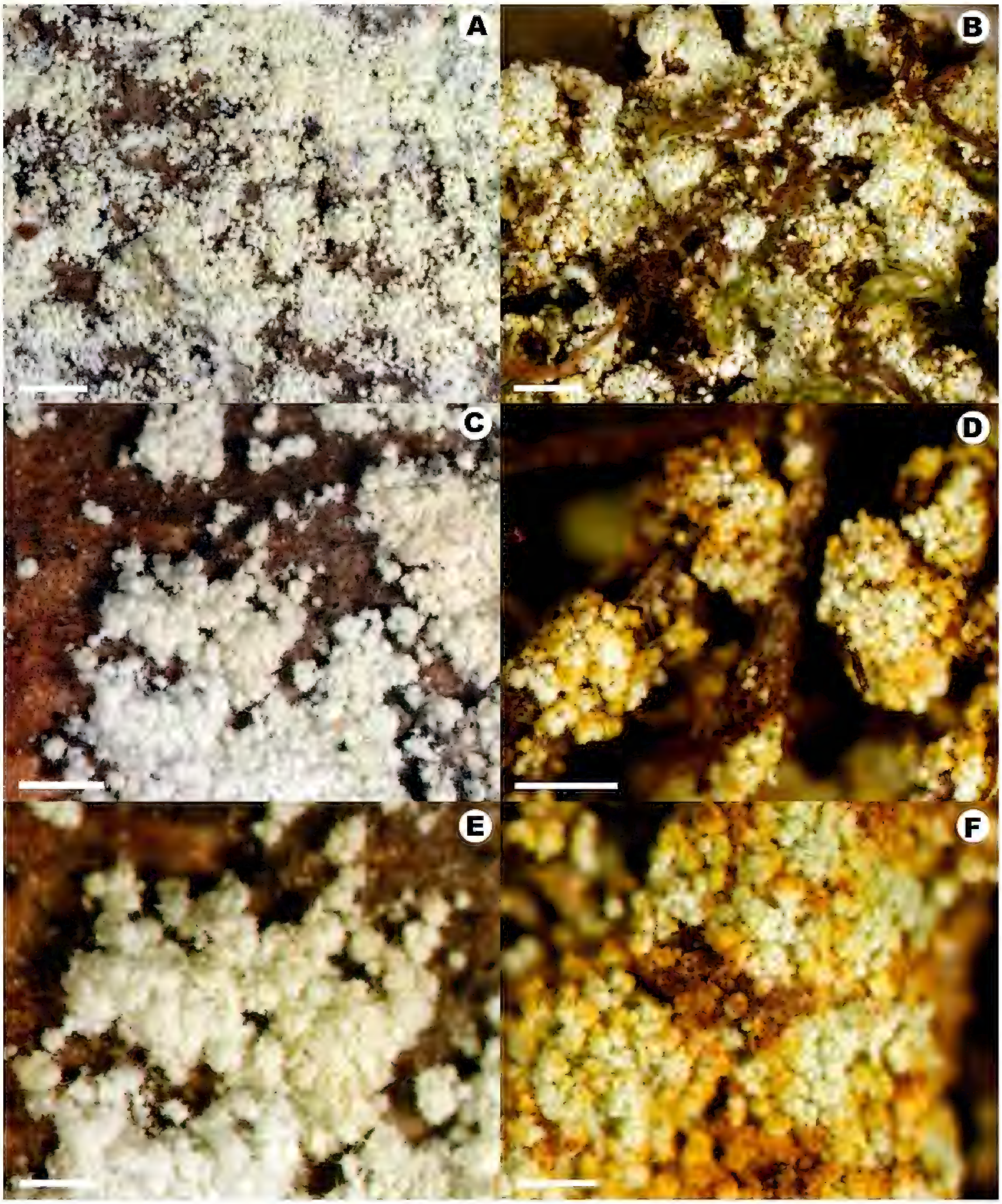

Figure 10, comparison of North American populations of *Lepraria diffusa* (left, from *Lendemer 22344*) and *L. diffusa* "var. *chrysodetoides*" (right, from *McCune 30488*). A–B, gross morphology of the thallus (scales = 1.0 mm). C–D, thallus surface (scales = 0.5 mm). E–F, detail of the granules (scales = 0.25 mm).

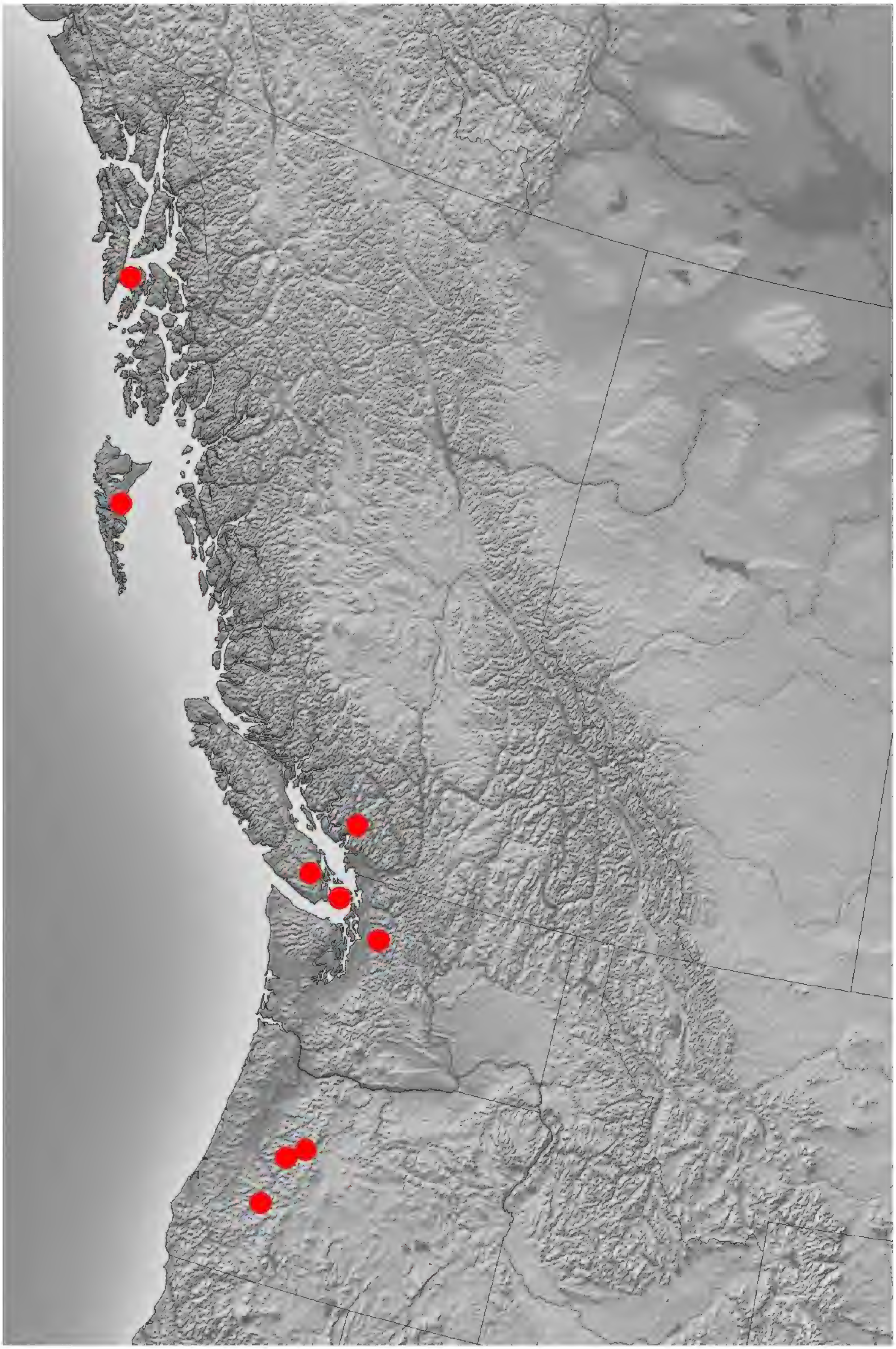

Figure 11, geographic distribution of *Lepraria diffusa* based on the specimens examined for this study.

5) *Lepraria eburnea* J.R. Laundon, Lichenologist 24: 331. 1992. TYPE: **ENGLAND:** London Borough of Hammersmith and Fulham (V.C. 21, Middlesex), All Saints Fulham churchyard, 51/243759, east side of churchyard, 30.vi.1987, in slight shade on moss, brick, and mortar on vertical surface of brick wall, *J.R. Laundon 3185* (BM [n.v.], holotype).

Lepraria frigida J.R. Laundon, Lichenologist 24: 332. 1992. TYPE: **SCOTLAND:** Tayside Region (V.C. 90, Forfar), Glenisla, Caenlochan Glen, 15.v.1964, on calcareous rocks, *P.W. James s.n.* (BM [n.v.], holotype).

FIGURES 12 AND 13.

Description. – **Thallus** crustose, leprose, placodioid, without crisped margins, continuous and distinctly bi-layered, initially forming small discrete thalli which expand marginally, overlap, and become confluent to form a thick crust (0.2–0.5 mm thick), dirty white to light yellowish-white; **hyphae** hyaline, [1.6]–(2.3)–2.9–(3.6)–[4.5] µm (*n*=100), septate, secund, obscured by a layer of POL+ crystals that do not dissolve in KOH; **prothallus** disappearing with age; **hypothallus** a variably developed layer of densely intertwined hyphae surrounding and subtending the granules, sometimes outward from the edge of thallus; **rhizohyphae** uncommon, not pigmented; **granules** globose, [22]–(33)–51–(68)–[114] µm (*n*=97), ecorticate, well organized and discrete, often forming compound units, sometimes separating from the hypothallus and then producing abundant projecting hyphae; **photobiont** green, coccoid, cells globose, [5.4]–(7.4)–9.3–(11.4)–[14.4] µm (*n*=97).

Chemistry. – Alectorialic acid, ± barbatolic acid, ± protocetraric acid. Spot tests: K-, C-, KC+ red, P+ yellow or orange-red, UV-.

Laundon (1992) described populations that produce protocetraric acid in additional to alectorialic acid as *L. frigida*. Later he considered the taxa to be synonymous when further study revealed that protocetraric acid was sometimes produced in low concentrations that could not be detected with TLC, and that the types of both names produced protocetraric acid. The positive reaction of alectorialic acid with a KC spot test is difficult to observe on the thallus. This test is best performed on an acetone extract of the thallus spotted on filter paper.

Ecology and distribution. – *Lepraria eburnea* primarily has a northern boreal distribution in North America (figure 13). It is particularly common in the Great Lakes Region and Canadian Maritime provinces, where it often grows on the bases of trees in swamps (especially *Thuja*). Although apparently absent from the central and southern Appalachian Mountains, the species is known from scattered localities in the central and southwestern United States where it occurs on shaded soil, especially of road banks. In western North America the species occurs in the Pacific Northwest with scattered disjunct occurrences extending southward in mountainous regions.

Conservation status. – In eastern North America *Lepraria eburnea* does not likely have significant conservation needs, as it is locally common where it occurs. The species typically occurs in swamps and other types of forested wetland habitats which are, generally speaking, more protected than other habitat types. The disjunct populations of *L. eburnea* in the central and southwestern United States may warrant some degree of conservation consideration. Long term monitoring of these populations would be particularly useful to evaluate the potential impacts of climate change, especially increased temperatures and decreased availability of moisture.

Discussion. – *Lepraria eburnea* is a distinctive species on account of its *finkii*-type placodioid thallus that produces alectorialic acid (figure 12). In most regions it is likely to be confused with *L. finkii*, which has the same ecology and whose geographic distribution is entirely sympatric. *Lepraria finkii* differs in producing atranorin, zeorin, and stictic acid and the thalli typically have a distinctive greenish-blue hue when fresh whereas those of *L. eburnea* are typically yellowish-white. In the Pacific Northwest, where *L. nivalis* occurs, confusion with that species is also possible. *Lepraria nivalis* does not produce alectorialic acid however (see that species for further details).

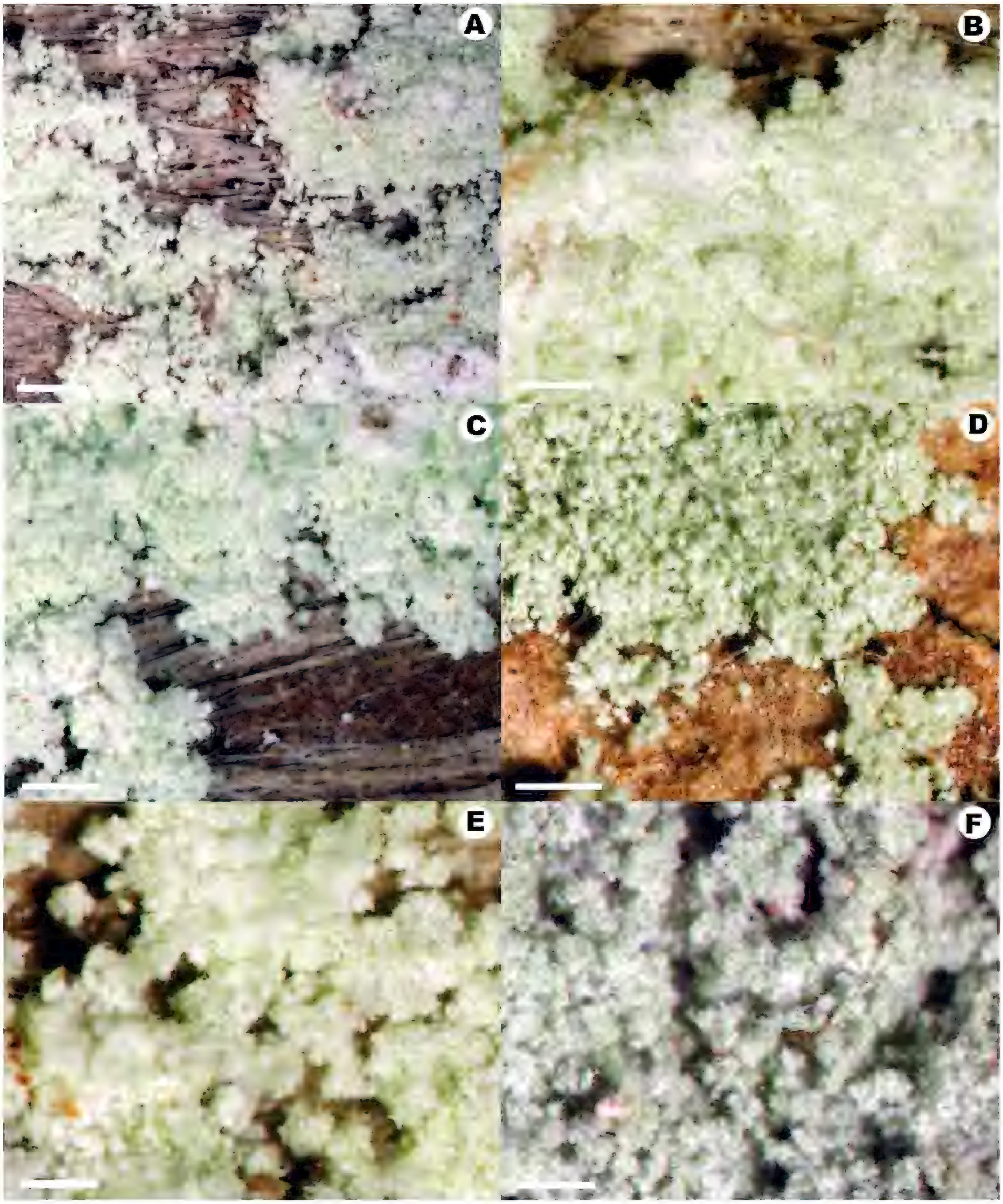

Figure 12, *Lepraria eburnea* (A–C and E from *Lendemer 22734*; D and F from *Lendemer 23046*). A, gross morphology of the thallus (scale = 1.0 mm). B, detail of the thallus margin (scale = 0.25 mm). C–D, aspect of the thallus margin (scales = 0.5 mm). E–F, detail of the granules (scales = 0.25 mm).

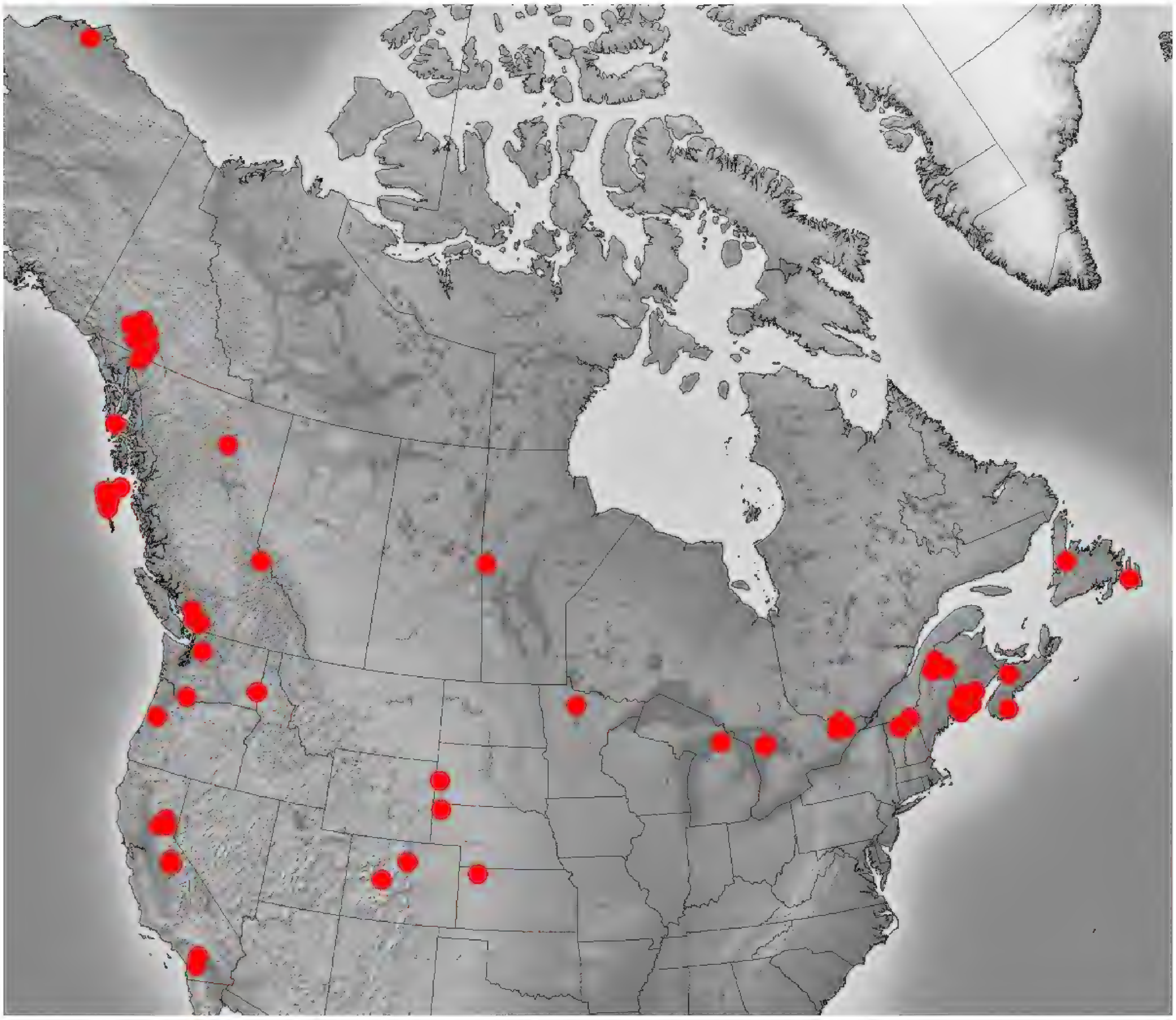

Figure 13, geographic distribution of *Lepraria eburnea* based on the specimens examined for this study.

Selected specimens examined (82 total seen from North America). – **CANADA. BRITISH COLUMBIA.** DEWDNEY-ALOUETTE DIST.: Golden Ears Provincial Park, 10.v.2009, on rock, *W.R. Buck 54701* (NY). GREATER VANCOUVER REGIONAL DIST.: Lynn Headwaters Regional Park, E side of Lynn Creek, 24.v.2010, on *Populus*, *J.C. Lendemer 22312 & A. Moroz* (NY). QUEEN CHARLOTTE ISLANDS: Haida Gwaii, Graham Island, along the road between Rennell Sounds and the main road junction, 15.vii.2010, on organic matter in deep rock crevice, *J. Harpel 48560 & S. Joya* (NY). **NEW BRUNSWICK.** CHARLOTTE CO.: Saint James Parish, Grand Falls Flowage, 20.iv.2011, on *Fraxinus*, *J.C. Lendemer 27913* (NY). **NEWFOUNDLAND & LABRADOR:** NEWFOUNDLAND: Placentia East Distr., Cataracts Provincial Park, 5.viii.1978, on mosses, *T. Ahti 34863* (H). **NORTHWEST TERRITORIES:** Axel Heiberg Island, White Glacier, sine date, on soil, *M. Kuc L47* (CANL); Hans Island, 18.vii.1972, on humus, *S.D. MacDonald & I.V. MacDonald s.n.* (CANL). **NOVA SCOTIA.** COLCHESTER CO.: Five Islands Provincial Park, N of Bentley Branch Rd., 16.v.2004, on *Betula, R.C. Harris 49881* (NY). **ONTARIO.** BRUCE CO.: Bruce Peninsula National Park, Halfway Log Dump on Georgian Bay, 19.ix.2008, on *Thuja*, *R.C. Harris 54913* (NY). LANARK CO.: N of Peneshula Rd. 0.6 mi W of int. w/ Cedar Creek Rd., 21.v.2011, on *Thuja*, *J.C. Lendemer 28296 & R.E. Lee* (NY). OTTAWA-CARLTON CO.: City of Ottawa, Stony Swamp, 19.v.2011, on *Thuja*, *J.C. Lendemer 28108 & I.M. Brodo* (NY). **CHILE. BÍO BÍO PROV.:** Alto Bío Bío, RN Ralco, vicinity of Laguna la Mula, 11.iv.2009, on bryophytes in sheltered overhang, *J.C. Lendemer et al. 16110* (NY). **ENGLAND:** Mid-West York, Kettlewell, Crab Gill, 6.v.1961, in moss, *S. Phillips s.n.* (NY). **U.S.A. ALASKA:** Washington Bay, Kuiu Island, 15.vii.1947, on moss, *W.J. Eyerdam 408* (NY). **CALIFORNIA.** MARIPOSA CO.: Yosemite National Park, vicinity of base of Bridal veil Falls, 22.ix.2009, on *Quercus* base, *J.C. Lendemer 19725*

(NY). NEVADA CO.: near Weaver Falls, 5 mi NE of Graniteville, 29.ix.2004, on dry basalt cliffs, *L. Ahart 11419* (SBBG). PLUMAS CO.: 1 mi SW of Blue Nose Mountain, 7.ix.2000, on shale, *L. Ahart 13242* (SBBG). RIVERSIDE CO.: San Bernardino National Forest, San Jacinto Mountains, vicinity of Boxwood Spring (Halfway Spring), 11.i.2008, on wood, *J.C. Lendemer 11487 & K. Knudsen* (NY). SAN DIEGO CO.: Cleveland National Forest, Palomar Mountain, shaded drainage near Will Valley, 1.ii.2006, on rock, *K. Knudsen 5122 & J.C. Lendemer* (NY, UCR). **COLORADO.** BOULDER CO.: Upper Gregory Canyon, ~1 mi W of Boulder, 15.viii.1974, on bryophytes, *G. Kunkel L-602* (COLO). GRAND CO.: NW slope of Taylor Peak, 17.vii.1963, on humus, *R.A. Anderson 4107* (COLO). **KANSAS.** RAWLINS CO.: ~7.5 mi S, 11.5 mi E of Atwood, 12.vi.2007, over *Molendoa* on seep on bluff, *C.A. Morse 15411 & E.M. Smith* (KANU, NY). **MAINE.** AROOSTOOK CO.: Presque Isle Township, 1.x.1988, on *Thuja*, *S. Selva 3729A & T. Marsh* (UMFK). HANCOCK CO.: T10SD, Maine Public Reserve Land, S slopes of Tunk Mountain, 10.vi.2010, on *Acer*, *J.C. Lendemer 23046* (NY). WASHINGTON CO.: Town of Cutler, Coastal Public Lands, Loop Trail via Black Point Cove Cutoff, 8.vi.2010, on *Thuja*, *J.C. Lendemer 22734* (NY). **MICHIGAN.** CHEBOYGAN CO.: Mill Creek SW from U.S. Hwy 23, 1.viii.1974, on humus soil, *R.C. Harris 9290* (NY). **MINNESOTA.** BELTRAMI CO.: ~3 mi N of Kelliher, 8.viii.1975, on *Thuja*, *W.R. Buck B387* (NY). **NEBRASKA.** SIOUX CO.: Fort Robinson State Park, 2 mi NW of Fort Robinson, 28.v.1988, on soil, *R.S. Egan 13376* (NY). **NEW HAMPSHIRE.** COOS CO.: Town of Stewartstown, Hurlbert Swamp Preserve, 17.v.2008, on base of *Thuja*, *R.C. Harris 54449* (NY). **OREGON.** JOSEPHINE CO.: Siskiyou Mountains, 0.3 mi SSW of Chalet, xii.2001, on moss/plant debris, *A. Mikulin 4-LIPK* (NY, OSC). LAKE CO.: Glass Butte, 0.8 mi S of Hwy 20, 16.x.2009, on soil, *H.T. Root 1784b* (NY, OSC). **SOUTH DAKOTA.** PENNINGTON CO.: 3 mi SW of Rochford, 21.vii.1960, on soil, *C.M. Wetmore 7878* (MSC). **VERMONT.** CALEDONIA CO.: Town of Wheelock, Wheelock Farm, 22.x.2010, on *Thuja*, *J.C. Lendemer 27569 & M. Sundue* (NY). **WASHINGTON.** SNOHOMISH CO.: Mount Baker-Snoqualmie National Forest, near South Fork Stillaguamish River, iii.2009, on phyllite outcrops, *B. McCune 29942* (NY).

6) *Lepraria elobata* Tønsberg, Sommerfeltia 14: 197. 1992. TYPE: **NORWAY:** Vest-Agder, Kristiansand, Hamresand, 5 m, 28.ix.1991, on *Pinus sylvestris*, *T. Tønsberg 17404* (BG!, holotype).

Lepraria salazinica Tønsberg, Opuscula Philolichenum 4: 52. 2007. TYPE: **U.S.A. NORTH CAROLINA.** SWAIN CO.: Great Smoky Mountains National Park, Balsam Mountain, along Balsam Mountain Rd., 4 miles (along the road) from the gate (near the end of Heintooga Rd.), 1420–1450 m, 20.vi.2002, saxicolous under overhang, *T. Tønsberg 30941* (BG!, holotype).

FIGURES 14–16.

Description. – **Thallus** crustose, leprose, aggregated, discontinuous and not stratified, initially composed of isolated granules that divide to form aggregations, eventually merging to form a thin crust (<0.1 mm thick), greenish-gray in color; **hyphae** hyaline, [1.4]–(2.3)–2.9–(3.6)–[4.8] µm (*n*=96) in width, septate, secund, obscured by a thick layer of POL+ crystals that dissolve in KOH; **prothallus** persistent; **hypothallus** absent; **rhizohyphae** absent; **granules** globose, [18]–(27)–35–(42)–[62] µm (*n*=155) in diameter, ecorticate, well organized and discrete, remaining distinct and not forming compound units; **photobiont** green, coccoid, cells globose, [4.8]–(7.0)–9.0–(11.0)–[16.8] µm (*n*=96) in width.

Chemistry. – Chemotype 1: atranorin, zeorin, stictic acid agg.; spot tests: K+ yellow turning dirty brownish, C-, KC-, P+ orange, UV-. Chemotype 2: atranorin, zeorin (in low concentrations, occasionally absent), roccellic/angardianic acid (occasionally in low concentrations), salazinic acid; spot tests: K+ yellow turning red, C-, KC-, P+ yellow, UV-.

Ecology and distribution. – In the expanded circumscription proposed by Lendemer (in press.) *Lepraria elobata* is an infrequent but widely distributed species throughout boreal/northern North America, extending southward at high elevations of the major continental mountain ranges (i.e., the Sierra Nevada and Peninsular Ranges, Rocky Mountains, and Appalachian Mountains). The salazinic acid chemotype is restricted to eastern North America and apparently allopatric with the stictic acid chemotype (figure 16). The species occurs on non-calcareous rocks in sheltered microhabitats, on soil and organic substrates in similar habitats, and on the bases of trees in humid habitats especially along the margins of conifer swamps.

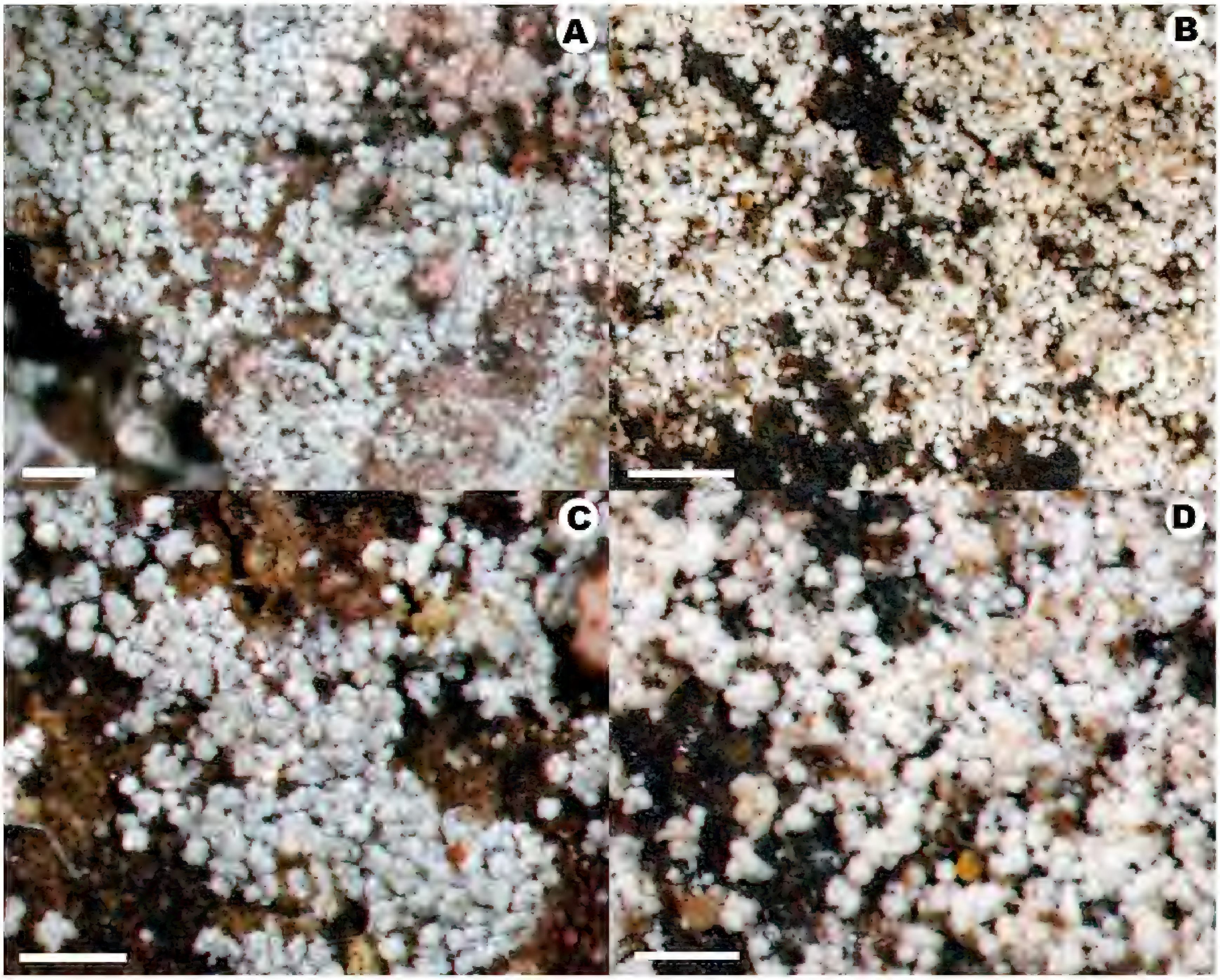

Figure 14, comparison of the holotypes of *Lepraria elobata* (*Tønsberg 17404*, left) and *L. salazinica* (*Tønsberg 30941*, right). A–B, gross morphology of the thallus (scales = 0.25 mm and 0.5 mm respectively). C–D, detail of the granules (scales = 0.25 mm).

Conservation status. – *Lepraria elobata* is widespread and, overall, does not likely warrant conservation consideration. The chemotype with salazinic acid is rare and geographically restricted, thus it could be considered in future conservation and management plans.

Discussion. – *Lepraria elobata* is characterized by its aggregate thallus and secondary chemistry (figures 14A–B and 15). Populations of *L. neglecta* with zeorin and stictic acid could be confused with *L. elobata*, however, that taxon has a thallus in which the granules develop a thick pseudocortex and appear compact. *Lepraria caesiella*, which is sympatric with *L. elobata* in some regions, also produces zeorin and atranorin, but it lacks salazinic acid and stictic acid, producing pallidic acid instead. Historically, *L. elobata* has been confused with *L. finkii* (i.e., *L. lobificans* auct.) because both species produce atranorin, zeorin, and stictic acid. The two species are morphologically distinct as *L. finkii* has a thick placodioid thallus of the *finkii*-type whereas *L. elobata* has an aggregate thallus of the *caesiella*-type (Lendemer 2011a).

Selected specimens examined (36 total seen from North America; chemotype 1). –**CANADA. NEW BRUNSWICK.** CHARLOTTE CO.: Grand Falls Flowage, 30.iv.2011, on *Abies* base, *J.C. Lendemer 27871* (NY). **NEWFOUNDLAND & LABRADOR.** NEWFOUNDLAND: Lookout Mountain, 19.vii.2006, on conifer bark, *J.C. Lendemer 8516* (NY). **NORTHWEST TERR.:** Daring Lake, 26.viii.2011,

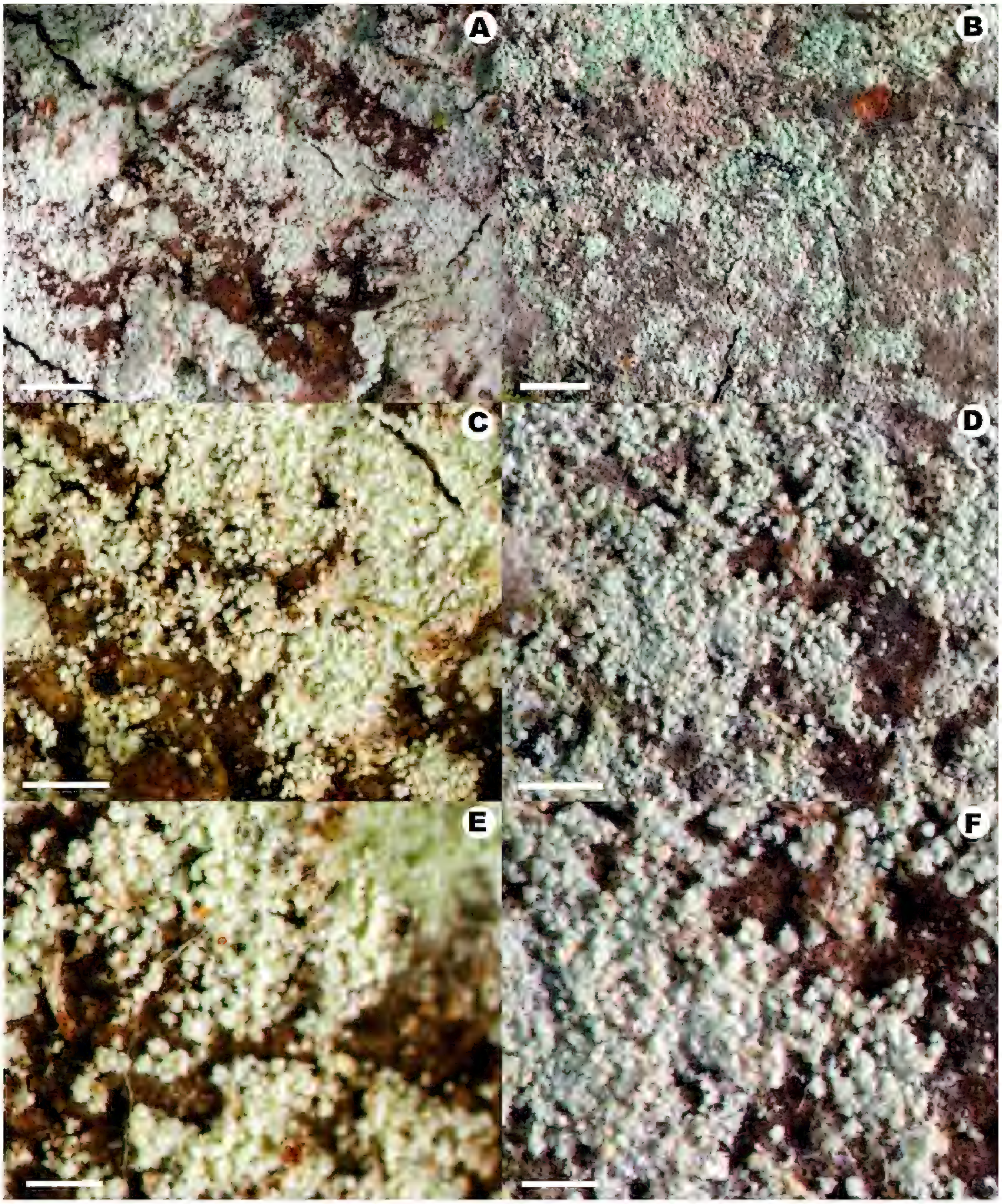

Figure 15, North American populations of *Lepraria elobata* (*Lendemer 28116* is left; *Lendemer 28349A* is right). A–B, gross morphology of the thallus (scales = 1.0 mm). C–D, detail of thallus morphology (scales = 0.5 mm). E–F, detail of the granules (scales = 0.25 mm).

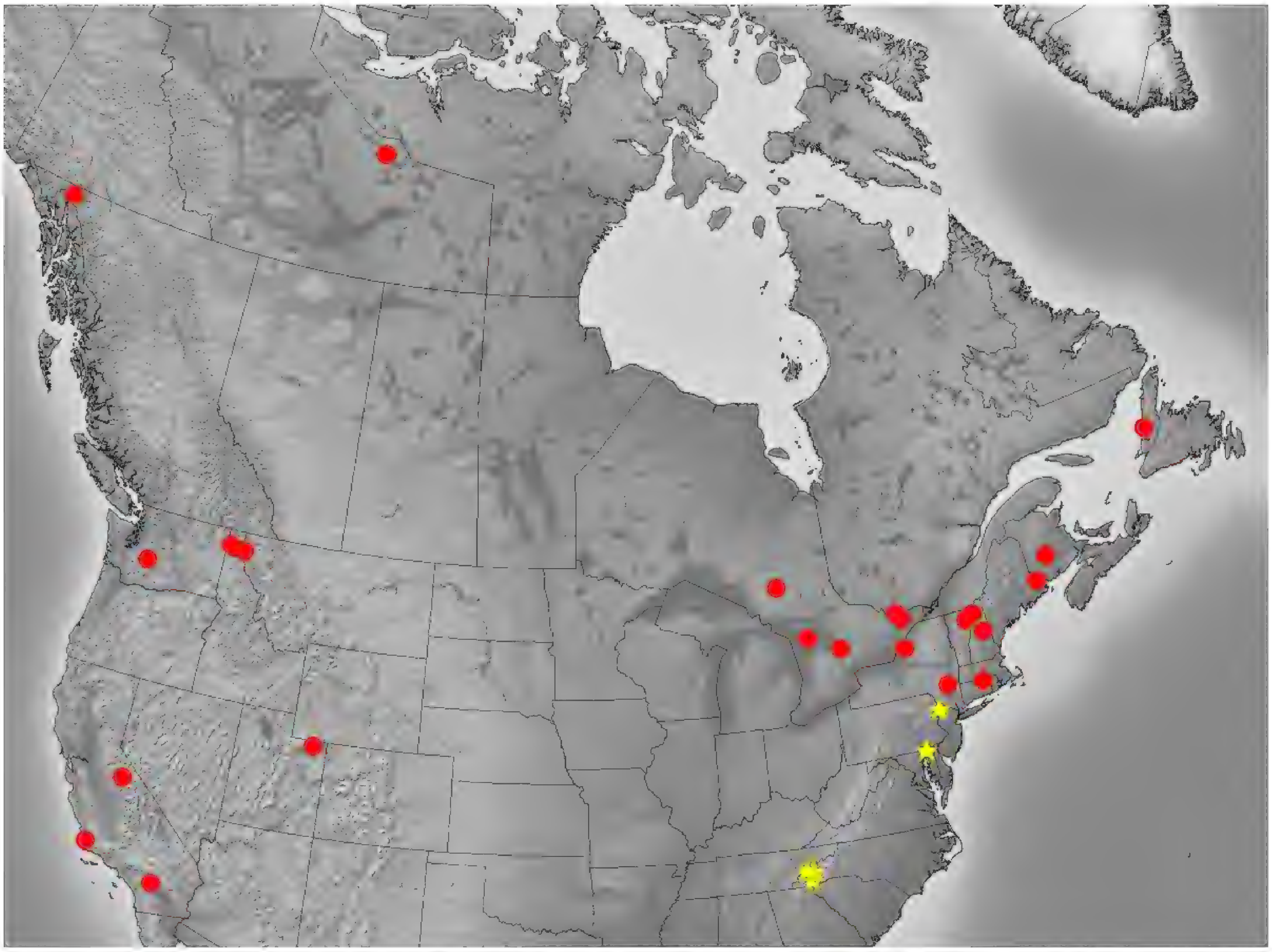

Figure 16, geographic distribution of *Lepraria elobata* based on the specimens examined for this study (red dots = typical chemotype, yellow stars = salazinic acid chemotype).

on sandy soil, *C. Lewis 747* (CANL, NY). **ONTARIO.** OTTAWA-CARLTON CO.: City of Ottawa, Stony Swamp, 19.v.2011, on *Populus* stump, *J.C. Lendemer 28116 & I.M. Brodo* (NY). SUDBURY DIST.: Wakamai Provincial Park, 55 km SE of Chapleau, 18.vii.2011, on rock, *I.M. Brodo 33000 & F. Brodo* (CANL). **QUEBEC.** PONTIAC MNP.: Gatineau Park, Church Hill, 22.v.2011, on *Pinus* base, *J.C. Lendemer 28349-A & C. Freebury* (NY). **U.S.A. CALIFORNIA.** MARIPOSA CO.: Yosemite National Park, Mount Hoffman marble outcrops, 21.ix.2009, on soil, *J.C. Lendemer 19670* (NY). RIVERSIDE CO.: San Bernardino National Forest, San Jacinto Mountains, Fuller Ridge, 2.x.2008, on granite in overhang, *J.C. Lendemer 14612 & K. Knudsen* (NY). **IDAHO.** BONNER CO.: Sandpoint, 8.v.2005, on conifer bark, *D.T. Perlmutter s.n.* (NCU [n.v.], NY). **NEW YORK.** GREENE CO.: Catskill Mountains, E end of Mink Hollow, 8.x.2007, on rock in overhang, *J.C. Lendemer 9804 & A. Moroz* (NY). **UTAH.** UNITAH CO.: Ashley National Forest, vicinity of Leidy Peak, 31.vii.2009, on *Selaginella*, *W.R. Buck 55092* (NY). **VERMONT.** CALEDONIA CO.: Town of Wheelock, Wheelock Farm, 22.x.2010, on *Abies*, *J.C. Lendemer 27625 & M. Sundue* (NY).

Specimens examined (5 total seen from North America; chemotype 2). – **U.S.A. CONNECTICUT.** WINDHAM CO.: Town of Westford, Yale Myers Forest, 19.ix.2009, on vertical rock face, *R.C. Harris 55666* (NY). **MARYLAND.** CECIL CO.: S/E shore of Octoraro Creek, 26.v.2009, on rock in overhang, *J.C. Lendemer 17830* (NY). **NEW JERSEY.** SUSSEX CO.: Delaware Water Gap, 26.iv.1975, on exposed rock, *C.R. Prince 75-32* (NY). **NORTH CAROLINA.** HAYWOOD CO.: Great Smoky Mountains National Park, E slopes above Caldwell Fork, 4.viii.2009, on rock in overhang, *J.C. Lendemer 18957 & E.A. Tripp* (NY). **PENNSYLVANIA.** PIKE CO.: Delaware Water Gap National Recreation Area, 23.iv.2004, on rock, *R.C. Harris 49483* (NY).

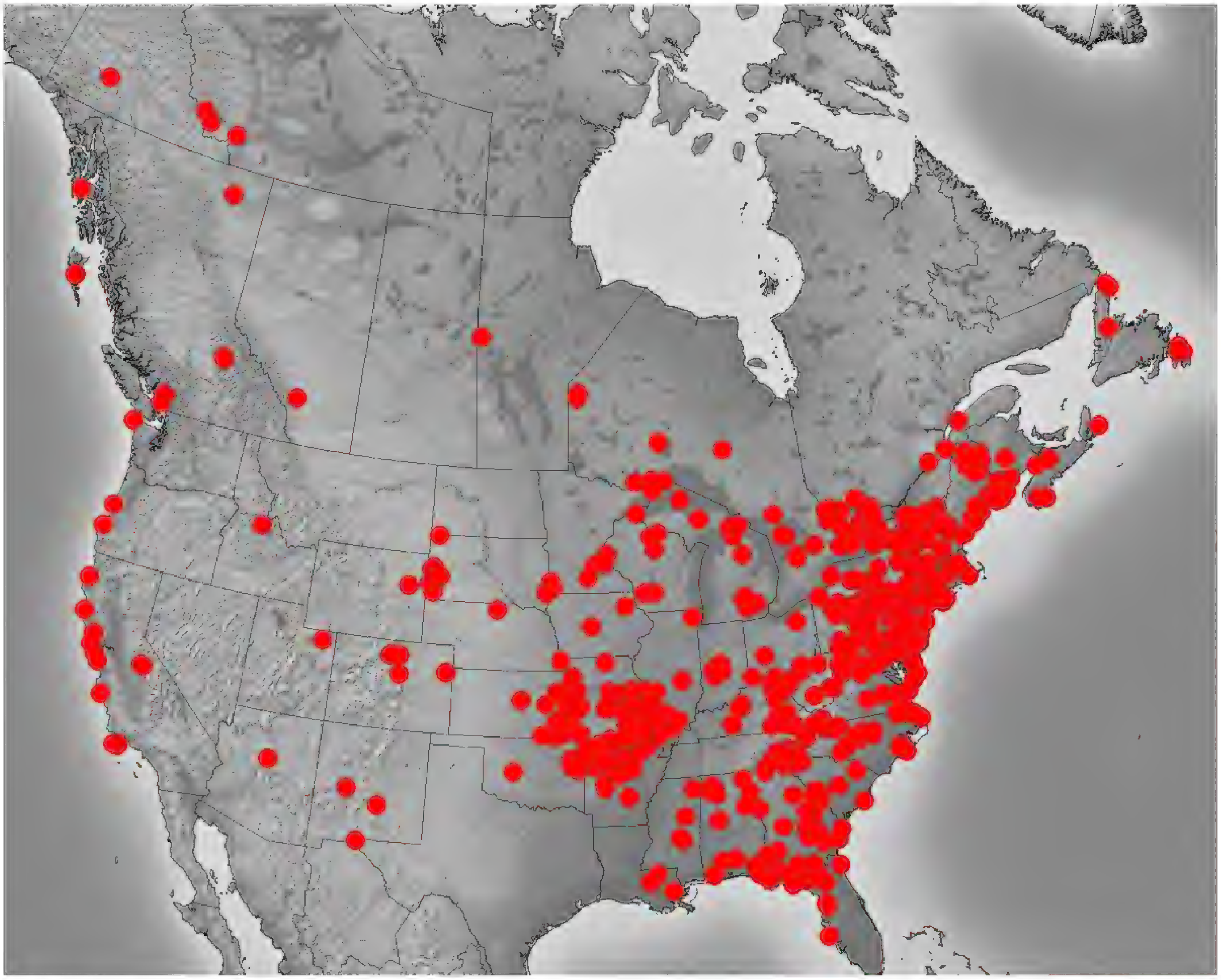

Figure 17, geographic distribution of *Lepraria finkii* based on the specimens examined for this study.

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7) ***Lepraria finkii* (B. de Lesd.) R.C. Harris,** Evansia 2: 45. 1985.

Crocynia finkii B. de Lesd., Bull. Soc. Bot. France 71: 334. 1924. TYPE: **U.S.A. IOWA.** FAYETTE CO.: Fayette, 7.vii.1894, on moss and limestone, *B. Fink s.n. = Decades N. American Lich. #161* and = *Lich. Boreal-Americani #93* (NY! [barcode 1196926], lectotype [selected by Harris 1985]; COLO!, DUKE!, NY! [barcode 1196927], isolectotypes).

FIGURES 17 AND 18.

Description. – **Thallus** crustose, leprose, placodioid, without crisped margins, continuous and distinctly bi-layered, initially forming small discrete thalli which expand marginally, overlap, and become confluent to form a thick crust (0.2–0.8(–1.0) mm thick), greenish-blue; **hyphae** hyaline, [2.4]–(2.6)–3.1–(3.6)–[4.8] µm (*n*=107), septate, secund, obscured by a layer of POL+ crystals that do not dissolve in KOH; **prothallus** disappearing with age; **hypothallus** a variably developed layer of densely intertwined hyphae surrounding and subtending the granules, sometimes outward from the edge of thallus; **rhizohyphae** uncommon, not pigmented; **granules** globose, [24]–(33)–48–(63)–[104] µm (*n*=166), ecorticate, well organized and discrete, rarely forming compound units, sometimes separating from the hypothallus and then producing abundant projecting hyphae; **photobiont** green, coccoid, cells globose, [4.8]–(6.8)–9.1–(11.3)–[15.6] µm (*n*=97).

Chemistry. – Atranorin, zeorin, ± roccellic/angardianic acid (trace), norstictic acid (trace), stictic acid aggregate, ± two unidentified spots (UV+ dull yellowish-white in long wave UV before charring) above and below stictic acid in Solvent C. Spot tests: K+ dull yellow-brown, C-, KC+ dull yellow-brown, P+ orange, UV-.

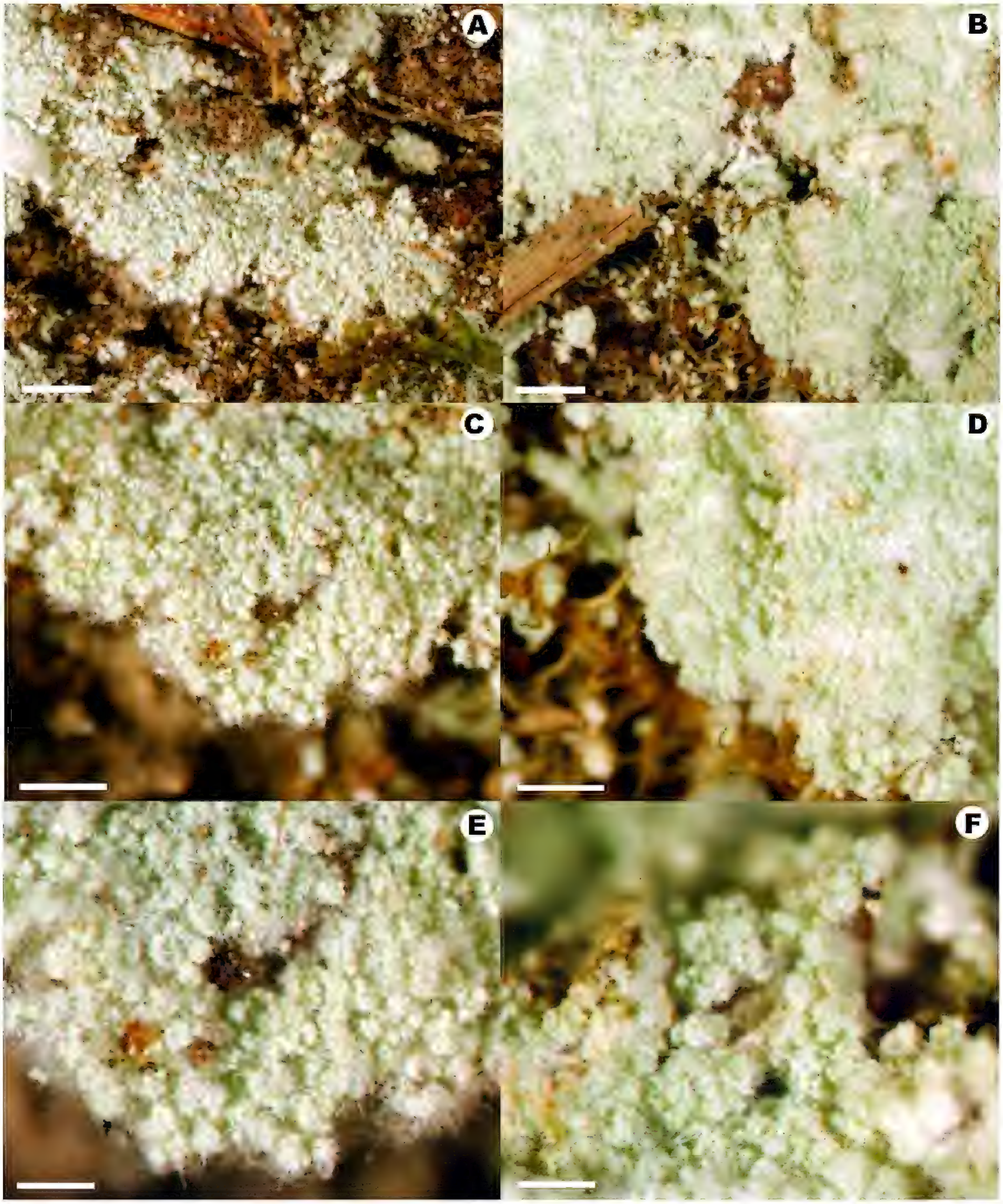

Figure 17, *Lepraria finkii* (*Lendemer 29677* is left; *Lendemer 27521* is right). A–B, gross morphology of the thallus (scales = 1.0 mm). C–D, detail of the thallus margins (scales = 0.5 mm). E–F, detail of the granules (scales = 0.25 mm).

The two unidentified spots mentioned above may represent dibenzofurans. If so, however, then they are not the same as any of the dibenzofurans currently reported from *Lepraria*. These spots are present in the vast majority of specimens examined and are not restricted to those from any given substrate.

Ecology and distribution. – *Lepraria finkii* is the most common and widely distributed species of the genus that occurs in North America. It is ubiquitous throughout eastern North America, except in the Arctic and tropical regions (figure 17). In western North America it is less frequent in northern and temperate areas, but nonetheless widespread. Scattered disjunct populations occur in mountainous regions of the arid Southwest and western interior.

The species shows no specific ecological requirements except the need for shade and humidity typical of its congeners. Indeed, these two factors likely account for its absence, or rarity, in the arid regions of the western and southwestern United States. The ability of this species to tolerate disturbance and pollution is also remarkable, as it often can be found on old shaded stone walls in highly urbanized areas (it occurs in every borough of New York City). Interestingly, *L. finkii* is the only North American member of *Lepraria* s. str. that occurs on calcareous rocks.

Conservation status. – *Lepraria finkii* is not considered to warrant any conservation concerns at this time.

Discussion. – Most readers will know *Lepraria finkii* as *L. lobificans*, because that is the name that has been used for this taxon since Laundon (1992) placed the two names in synonymy. As has been discussed elsewhere (Lendemer 2010a), examination of the type specimen of *L. lobificans* has confirmed that in fact it is conspecific with *L. santosii* as presently circumscribed (Tretiach et al. 2009) and not *L. finkii*. Thus I here formally place *L. santosii* in synonymy with *L. lobificans*[3] and take up the name *L. finkii* for the common species previously referred to as *L. lobificans*.

Lepraria finkii is paradoxically one of the most easily recognizable and easily confused species of *Lepraria*. The combination of a *finkii*-type placodioid thallus and production of atranorin, zeorin, and stictic acid are distinctive. Nonetheless, the species is sympatric with nearly every other species known from the continent, and reliance on spot tests alone for identification can potentially lead to confusion.

Only three species are chemically similar to *Lepraria finkii* in producing atranorin and stictic acid. *Lepraria elobata* produces these substances as well as zeorin. However, it does not produce the two unknowns mentioned above and it has an aggregate rather than placodioid thallus. The stictic acid-producing chemotype of *L. neglecta* is chemically similar to *L. finkii*, and indeed some populations even produce zeorin. However, that species has an aggregate thallus in which the granules develop a distinct pseudocortex. *Lepraria leprolomopsis* is most likely to be confused with *L. finkii* as it is morphologically identical and entirely sympatric in North America. The only distinguishing feature of *L. leprolomopsis* is that it lacks zeorin, and in some cases produces abundant anthraquinones on the underside of the thallus. Further studies with molecular data are needed to elucidate whether *L. leprolomopsis* is a distinct taxon or merely a chemical variant of *L. finkii*. It should be noted that the report of *L. finkii* (sub. *L. lobificans*) from Fiji by Lumbsch et al. (2011) requires confirmation as those authors did not mention the occurrence of zeorin in the material they examined.

Selected specimens examined (1177 total seen from North America). – **CANADA. ALBERTA:** S side of the Bow River, beside the Bearspaw Dam, W of Calgary, 4.ix.1963, on sandstone, *C.F. Bird 9002* (COLO). **BRITISH COLUMBIA.** GREATER VANCOUVER REGIONAL DIST.: City of Vancouver,

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[3] *Lepraria lobificans* Nyl., Flora 56: 196. 1873. TYPE: **FRANCE:** Pyrénées-Orientales, Collioure, 4.vii.1872, [on soil], *W. Nylander s.n.* (H-NYL-10864!, lectotype [selected by Laundon 1992]; H-NYL-10865!, isolectotype).

Leproloma lobificans (Nyl.) Boistel, Nouv. Fl. Lich. 2: 318. 1903.

Lepraria santosii Argüello & A. Crespo *in* Crespo et al., Lichenologist 38: 218. 2006, syn. nov. TYPE: **SPAIN. CANARY ISLANDS:** Tenerife, Las Mercedes, acantilado del borde de la carretera, 28.iii.2005, on soil, *A. Crespo s.n.* (MAF [n.v.], holotype; GZU!, isotype).

See figure 19 for a comparison of the lectotype of *L. lobificans* and an isotype of *L. santosii*.

University of British Columbia Campus, W of int of W Mall and NW Marine Dr., 23.v.2010, on *Acer*, *J.C. Lendemer 22302 & A. Moroz* (NY). QUEEN CHARLOTTE ISLANDS: Skidegate Inlet, Balch Island (North), at entrance to Maude Channel, 14.vii.1967, on rock, *I.M. Brodo 11529 & M. Shchepanek* (NY). SQUAMISH-LILLOOET DIST.: Murrin Provincial Park, around Browning Lake, 11.v.2000, on bryophytes on rock face, *W.R. Buck 54792* (NY). **MANITOBA:** SE of Flin Flon, Little Spruce Lake Rd., 24.v.2004, on mossy rock face, *T. Ahti et al. 62914* (H, NY). **NEW BRUNSWICK.** CHARLOTTE CO.: Pennfield Parish, W of Jake Lee Rd., 1.v.2011, on *Acer*, *J.C. Lendemer 27955* (NY); Saint Patrick Parish, Caughey-Taylor Nature Preserve, E of NB127, 2.v.2011, on *Thuja* base, *J.C. Lendemer 28094* (NY). **NEWFOUNDLAND AND LABRADOR.** NEWFOUNDLAND: Island of Newfoundland, Avalon Peninsula, Hawke Hills, 7.ix.2007, on rocks and soil, in overhang, *J.C. Lendemer 9957* (NY); Island of Newfoundland, Northern Peninsula, Ha-Ha Mountain, 20.viii.2007, on soil, in overhang, *J.C. Lendemer 10546 & A. Moroz* (NY); White Bay South Region, Sop's Arm W, Main River Forest Access Rd., 6.ix.2011, on rock, *T. Ahti 70738i* (H, NY). **NOVA SCOTIA.** CUMBERLAND CO.: Cape Chignecto Provincial Park, along trail from Red Rocks to McGahey Brook, 15.v.2004, on soil, *R.C. Harris 49806* (NY). LUNENBURG CO.: Upper Lattare, Beck's Lake, 28.xii.2008, on *Acer*, *F. Anderson s.n.* (NY). QUEENS CO.: Thomas H. Raddall Provincial Park, 7.v.1999, on rock, *R.C. Harris 42935* (NY). SHELBURNE CO.: along Hwy 302 just S of Upper Ohio, at Philip Lake, 9.v.1999, on *Betula*, *R.C. Harris 43077* (NY). **ONTARIO.** BRUCE CO.: Bruce Peninsula National Park, just SW of parking area for Halfway Log Dump, 20.ix.2008, on log, *J.C. Lendemer 14291* (NY). KENORA DISTR.: NE bay of Stout Lake, 44 km E of Manitoba border, 30.vi.2011, on bryophytes, *S.R. Brinker 2042* (NY). LANARK CO.: N of Peneshula Rd. 0.6 mi W of int w/ Cedar Cove Rd., 21.v.2011, on *Thuja*, *J.C. Lendemer 28290 & R.E. Lee* (NY). PETERBOURGH CO.: Jermyn-Indian River, 10 km E of Peterborough, 2.iii.2011, on *Acer*, *C. Lewis 515* (NY). SUDBURY DIST.: Hallum Twp., on S side of Hwy 17, 5.6 km W of Webbwood, 19.iv.2011, on rock, *C. Lewis 599* (NY). **QUEBEC.** KAMOURASKA CO.: Sainte-Anne de la Pocatière, 27.iv.1935, on soil, *E. LaPage 131* (NY). PONTIAC CO.: Gatineau Park, 0.3–0.5 mi E of parking area on Chemin Eardley Masham, 22.v.2011, on *Tsuga*, *J.C. Lendemer 28330 & C. Freebury* (NY). RIMOUSKI CO.: Bic, Pte. Des Epinettes, 24.vii.1907, on rock, *J.F. Collins 5118* (FH). **U.S.A. ALABAMA.** BALDWIN CO.: Volanta, 25.iii.1925, on sandy banks, *A.W. Evans 348* (FH). COVINGTON CO.: Conecuh National Forest, Solon Dixon Forestry Education Center, Blue Springs, 14.iv.2007, on *Ulmus*, *R.C. Harris 53496* (GZU, NY). ESCAMBIA CO.: Escambia Creek Wildlife Management Area, N of Conway Rd., 13.iv.2007, on *Persea*, *R.C. Harris 53361* (NY). JACKSON CO.: Pisgah, Jones Cove below Pisgah Civitan Park, 2.x.1999, on rock, *R.C. Harris 43323* (NY). LAWRENCE CO.: near Prairie Grove Glades, 3.i.2011, on *Juniperus*, *E. Tripp 1321* (NY). WINSTON CO.: Dismals Wonder Garden, 26.ix.1992, on rock, *R.C. Harris 28480* (NY). **ALASKA:** Washington Bay, Kuiu Island, 5.ix.1947, on large spruce, *W.J. Eyerdam 470* (NY). **ARIZONA.** COCOINO CO.: 1.5 mi up West Fork of Oak Creek Canyon, 13.v.1960, on sandstone, *S.A. Johnsen & T.N. Johnsen 892* (COLO). **ARKANSAS.** CLEBURNE CO.: N portion of North Unit of Big Creek Natural Area, 9.x.2010, on *Juniperus*, *J.C. Lendemer et al. 26363* (NY). FAULKNER CO.: Cove Creek Natural Area, 7.x.2010, on *Juniperus*, *J.C. Lendemer 26253* (NY). MADISON CO.: Sweden Creek Falls Natural Area, 5.x.2010, on mosses over rock, *J.C. Lendemer et al. 25942* (NY). NEWTON CO.: Ozark National Forest, E of FSR 1463, 2.6 mi N of AR 21, 28.iii.2006, on *Fagus*, *R.C. Harris 52296* (NY). PERRY CO.: Ouachita National Forest, vicinity of Goat Bluff along N side of South Fourche LaFarve River, 6.x.2010, on *Quercus*, *J.C. Lendemer et al. 26044* (NY). **CALIFORNIA.** MARIN CO.: Point Reyes National Seashore, Laguna Trail on way to beach camp, 9.vii.2008, on sandstone, *K. Knudsen 9876* (NY). MARIPOSA CO.: Yosemite National Park, bottom of Tuolumne Grove, 19.ix.2009, on *Abies*, *J.C. Lendemer 19564* (NY). MONTEREY CO.: Santa Lucia Mountains, Lime Kiln State Park, 11.ix.2007, on clay, *K. Knudsen 10274.1* (NY). SAN MATEO CO.: Golden Gate National Recreation Area, Sweeney Ridge, 28.i.2006, on *Cupressus*, *K. Knudsen et al. 5036* (FH). SANTA BARBARA CO.: Channel Islands, Santa Cruz Island, S of Canada Cervida along truck trail, 16.vi.2007, on *Adenostoma*, *K. Knudsen et al. 8572* (NY). SONOMA CO.: McMurray Ranch Winery, 12.vii.2008, on moss and old bark of *Umbellularia, K. Knudsen et al. 9916* (NY, UCR). **COLORADO.** GRAND CO.: Rocky Mountains National Park, 4.5 mi NE of Grand Lake, North Inlet, 20.vi.1959, on rock, *J. Douglass & M. Douglass s.n.* (COLO). LARIMER CO.: Big Thompson River Canyon, from 3 mi W of Loveland, vii-viii.1959, [on mosses], *R. Fahrenbruch s.n.* (COLO). **CONNECTICUT.** FAIRFIELD CO.: Town of Redding, Highstead Arboretum, 9.vi.2005, on *Quercus*, *R.C. Harris 51567* (NY). HARTFORD CO.: near Hartford, 21.vi.1911, on rock, *L.W. Riddle s.n.* (FH). LITCHFIELD CO.: Town of Caanan, Great Mountain Forest, Sam Yankee Woodlot, 20.ix.2003, on *Quercus*, *R.C. Harris 48027* (NY). NEW HAVEN

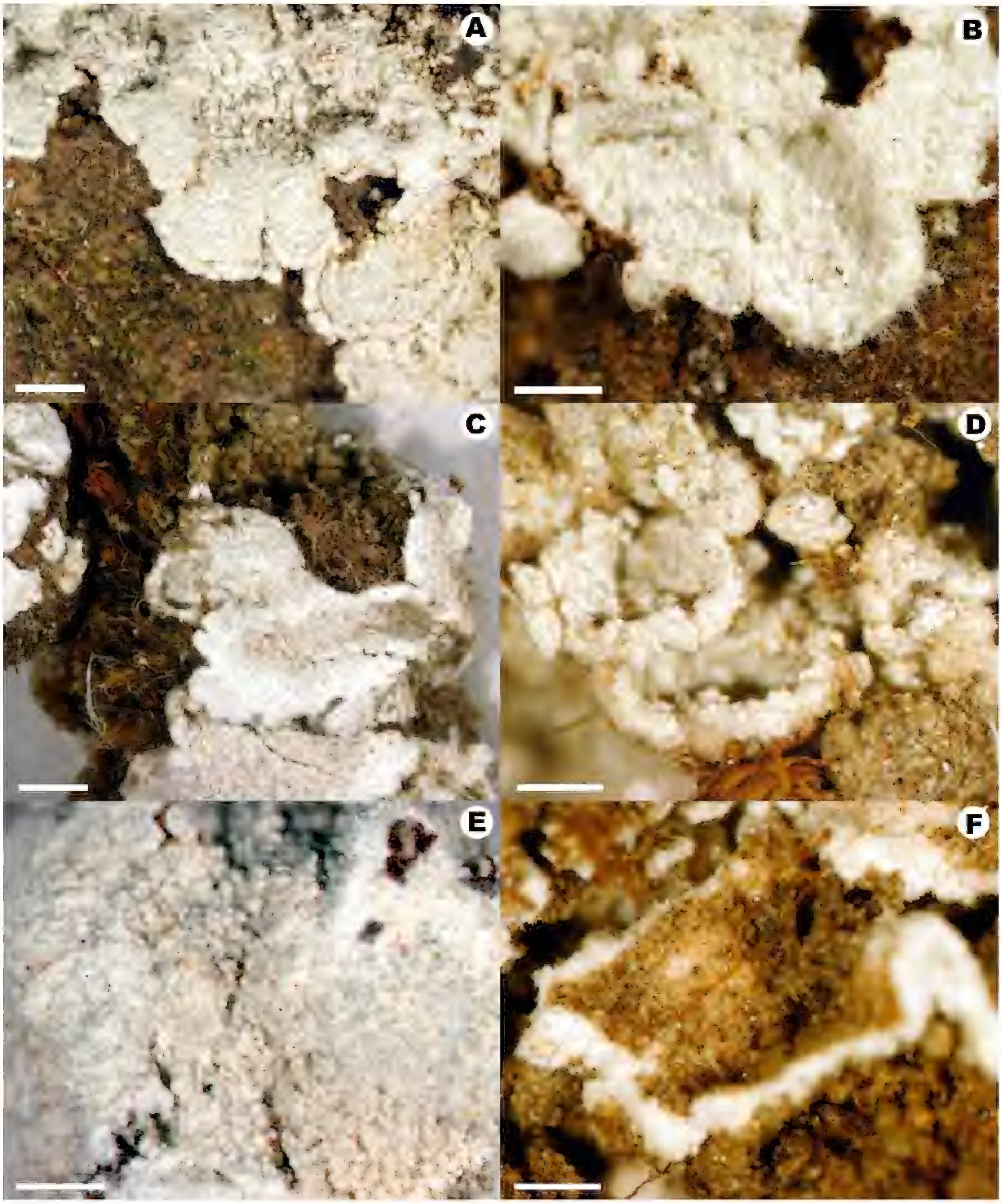

Figure 19, comparison of isotype of *Lepraria santosii* in GZU (A and B) with the lectotype of *L. lobificans* in H-NYL (C–F). A, gross morphology of the thallus in *L. santosii* (scale = 1.0 mm). B, detail of the thallus margin illustrating the crisped edge in *L. santosii* (scale = 0.5 mm). C, gross morphology of the thallus in *L. lobificans* (scale = 1.0 mm). D, detail of the thallus margin illustrating the crisped edge in *L. lobificans* (scale = 0.5 mm). E, thallus surface in *L. lobificans* (scale = 0.5 mm). F, lower surface in *L. lobificans* (scale = 0.5 mm).

CO.: Milford, 7.iv.1923, on rock[?], *A.W. Evans 56* (FH). WINDHAM CO.: Town of Westford, Yale Myers Forest, 19.ix.2009, on rock in overhang, *R.C. Harris 55661* (NY). **DELAWARE.** NEW CASTLE CO.: N of Walter S. Carpenter Jr. State Park, 19.i.1991, on trees, *C.F. Reed 133826* (NY). SUSSEX CO.: Ellendale State Forest, 25.x.1989, on *Liquidambar*, *R.C. Harris 24909* (NY). **FLORIDA.** ALACHUA CO.: Paynes Prairie State Preserve, vicinity of Alachua Sink, 1.xii.1992, on *Quercus*, *R.C. Harris 29463* (NY). CITRUS CO.: Withlacoochee State Forest, along Florida Trail N to Brush Sink from CR 480, 6.xii.1993, on rock, *R.C. Harris 31820* (NY). DUVAL CO.: Jacksonville Beach, NE corner of int. of N 20th St. and 2nd Ave. N., 9.iii.2009, on log, *J.C. Lendemer 15897 & W.R. Buck* (NY). GULF CO.: N of Lake Grove Rd. (SR22), 1.5 mi E of SR71 at Wewahitchka, 11.xii.1993, on *Taxodium*, *R.C. Harris 32191* (NY). HERNARDNO CO.: E of Brooksville, 6.viii.1964, on *Quercus*, *B.J. Moore 2065* (DUKE, NY). JACKSON CO.: Black Spring, ~1 mi W of FL167, 3.xii.1988, on *Carpinus*, *R.C. Harris 23338* (NY). **GEORGIA.** BAKER CO.: Ichauway Plantation/Jones Ecological Research Center, E shore of Ichauway-Notchaway Creek, 16.iv.2007, on *Quercus*, *J.C. Lendemer et al. 9507* (NY). COFFEE CO.: Broxton Rocks Ecological Preserve, Ricketson Tract, 4.ii.1995, on soil, under overhang, *R.C. Harris 38876* (NY). EARLY CO.: Williams Bluff Preserve, ~3 mi W of Cedar Springs, 15.iv.2007, on sandstone, *J.C. Lendemer et al. 9323* (NY). HEARD CO.: Camp Meeting Rock Preserve, 1.x.1999, over mosses, *W.R. Buck 36272* (NY). McINTOSH CO.: Sapelo Island, Sapelo Island Wildlife Management Area, West Perimeter Rd. 1 mi S of Kenan Fields, 10.xii.2009, on *Quercus*, *J.C. Lendemer 20797* (NY). TOWNS CO.: Chattahoochee National Forest, Hightower Gap to Rich Knob, 11.xi.2007, on *Acer*, *J.C. Lendemer et al. 10937* (NY). **ILLINOIS.** COLES CO.: Lakeview Park, ¼ mi E of Charleston, 4.ix.1986, on bark, *T. Motley 40* (NY). JACKSON CO.: Shawnee National Forest, Pomona Natural Bridge, 15.x.1993, on rock, *R.C. Harris 31274* (NY). SHELBY CO.: Hidden Springs State Forest, ~14 mi W of Neoga, 28.iv.1988, on bark, *R.C. Harris 21812* (NY). UNION CO.: Shawnee National Forest, Panther Den, 17.x.1993, on rock, *R.C. Harris 31434* (NY). **INDIANA.** MARION CO.: Miller, 5.x.1915, on sand banks, *R. Darrow 1031* (FH). OWEN CO.: Owen-Putnam State Forest, 3.2 mi W of Carp, 28.iv.1988, on bark, *R.C. Harris 21829* (NY). PUTNAM CO.: along bank of Big Walnut, 1 mi E of Bainbridge, 30.iv.1945, on soil, *K.A. Wagner 392* (NY). **IOWA.** BOONE CO.: Ledges State Park, ~4 mi S of Boone, 9.vii.2007, on sandstone, *M.K. Advaita 6478* (NY). FAYETTE CO.: Fayette, vii.1894, on calcareous rock and mosses, *B. Fink s.n.* (FH, NY). **KANSAS.** CHAUTAUQUA CO.: 2.25 mi S of Niotaze, along Birch Creek, 18.ix.2007, on *Betula*, *C.A. Morse 15698* (NY). CHEROKEE CO.: Spring River Wildlife Area, N of NE 100th St., 13.iv.2004, on sandstone, *W.R. Buck 46376* (NY). DOUGLAS CO.: “Baldwin Woods,” 3.iv.1954, on rock, *C.L. Kramer 346* (NY). ELLSWORTH CO.: Kanopolis State Park, 4 mi S, 2 mi E Carneiro, 27.iv.2008, on bluffs, *C.A. Morse 12699 & C.C. Freeman* (KANU, NY). **KENTUCKY.** BULLITT CO.: Bernheim Arboretum and Research Forest, near S end of Rice Orchard Ridge Rd., 24.x.2002, on mossy limestone, *D. Ladd 24038* (NY). EDMONSON CO.: Mammoth Cave National Par, Cedar Sink area, viii.1979, on soil, *J.P. Dey 12597* (NY). KNOTT CO.: 2 mi E of Hindman, 10.xi.1968, on soil, *C.F. Reed 80207* (NY). MASON CO.: Rt. 10, 2 mi W of Plumville, 9.xi.1980, on bark, *C.F. Reed 119875* (NY). PERRY CO.: Daniel Boone National Forest, Old Field Branch of Leatherwood Creek, 6.x.2001, on soil, *R.C. Harris 44962* (NY). **LOUISIANA.** EAST BATON ROUGE PARISH: Burden Research Plantation, southeast Baton Rouge, 8.iii.1977, on bark, *S.C. Tucker 16903* (NY). ORLEANS PARISH: New Orleans, near Industrial Canal, 14.iii.1939, on *Taxodium*, *F. Pennebaker s.n.* (NY). **MAINE.** Aroostook co.: T10 R8 WELS and T11 R8 WELS, near summit of Jack Mountain, 16.v.1985, on rock over moss, *S. Selva 1625 & T. Talarico* (UMFK). HANCOCK CO.: Town of Aurora, N-facing slopes above Middle Branch of the Union River, 11.vi.2010, on *Thuja*, *J.C. Lendemer 23225* (NY). KNOX CO.: Rockport, Cramer Park on N-facing slope of Goose River, 6.vi.2010, on limestone, *B. Shaw 9744* (NY). PISCATAQUIS CO.: T8 R10 WELS, Big Reed Pond TNC Preserve, 12.v.1987, on *Betula*, *S. Selva et al. 2574A* (UMFK). WALDO CO.: Town of Lincolnville, Ducktrap River Preserve, ~4 mi NE of Lincolnville Center on ME 52, 28.v.2009, on tree trunk, *W.R. Buck 54871* (NY). WASHINGTON CO.: T18 ED BPP, Maine Public Reserve Lands, S end of Rocky Lake, 9.vi.2010, on *Betula*, *J.C. Lendemer 22900* (NY). YORK CO.: Town of Alfred, Massabesic Experimental Forest, Southern Unit, 14.ix.2002, on face of erratic boulder, *R.C. Harris 46252* (NY). **MARYLAND.** ALLEGHANY CO.: Fort Hill, just NE of jct US220 and Potomac River, 24.iv.1989, on rock, *R.C. Harris 24621* (NY). ANNE ARUNDEL CO.: Furnace Branch, 15.x.1907, on *Acer*, *C.C. Plitt s.n.* (NY). CECIL CO.: New Valley, along Basin Run, Liberty Grove Rd., 1.xii.2009, on *Fraxinus*, *J.C. Lendemer 20010* (NY). KENT CO.: edge of Chester River, 2 mi SW of Chestertown, 7.viii.1989, on rock, *C.F. Reed 127487* (NY). MONTGOMERY CO.: Great Falls State Park, Bear Island, 25.iv.1993, on rock, *T. Ahti 51502 & D.H. Nicholson* (H, NY). **MASSACHUSETTS.** BERKSHIRE CO.: Town of Pittsfield, Pittsfield State

Forest, E of Lulu Cascade, 4.vi.2010, on *Acer*, *J.C. Lendemer 22479* (NY). FRANKLIN CO.: Town of Rowe, just off Tunnel Road, 3.8 mi NW of Zoar on River Rd., 19.ix.1998, on mosses, *R.C. Harris 42280* (NY). MIDDLESEX CO.: Cambridge, sine date, *E. Tuckerman s.n.* (NY). NORFOLK CO.: Wellesley, iv.1908, on stumps, *L.W. Riddle s.n.* (FH). **MICHIGAN.** JACKSON CO.: NW corner of intersection of I-94 and Race Rd., NE of Jackson, 15.vi.1979, on *Quercus*, *R.C. Harris 13082* (NY). WASHTENAW CO.: W of Merrill Rd., ~0.3 mi N of Barker Rd., W of Whitmore Lake, 10.vii.1979, on *Quercus*, *R.C. Harris 13131* (NY). **MINNESOTA.** BLUE EARTH CO.: Mankato, 23.vi.1899, on shaded rock, *J.R. Gardner 40* (NY). COOK CO.: Grand Portage Island, 17.vi.1897, on earth, *B. Fink 1* (NY). RAMSEY CO.: Mississippi River National River, Battle Creek Park in St. Paul, 16.vi.2008, on rock, *C.M. Wetmore 97019* (MIN, NY). **MISSISSIPPI.** ITAWAMBA CO.: Donivan Slough, Mile 283.3 along Natchez Trace Parkway, 28.ix.1992, on *Taxodium*, *R.C. Harris 28636* (NY). JASPER CO.: Bienville National Forest, along CR 506 at Little Tallahala Creek, 30.ix.1992, on *Quercus, R.C. Harris 28818* (NY). SCOTT CO.: Bienville National Forest, Bienville Pines Scenic Area, just SE of Forest, 29.ix.1992, on *Acer*, *R.C. Harris 28751* (NY). WINSTON CO.: Tombigee National Forest, Choctaw Wildlife Area, near int of FSR 954 & FSR 955S, 28.ix.1992, on *Carpinus*, *R.C. Harris 28672* (NY). **MISSOURI.** BOLLINGER CO.: Dark Cypress Swamp Conservation Area, 22.x.2001, on *Platanus*, *R.C. Harris 45212* (NY). IRON CO.: Pilot Knob National Wildlife Refuge, ~1 mi N of Ironton, 30.iii.2006, on soil, *R.C. Harris 52436* (NY). LINCOLN CO.: Cuiver River State Park, Big Sugar Creek Wild Area, 23.v.2003, on *Quercus*, *R.C. Harris 47830* (NY). MARIES CO.: Clifty Creek Natural Area, ~5.5 air mi ENE of Dixon, 4.x.2010, on *Quercus*, *J.C. Lendemer 25763 & D. Ladd* (NY). ST. FRANCOIS CO.: Buck Creek Winery, just NE of Buck Mountain Conservation Area, 9.x.2010, on *Juniperus*, *J.C. Lendemer 26640 & D. Ladd* (NY). WAYNE CO.: Sam A. Baker State Park, Shut-Ins Trail, 15.x.2003, on rock, *W.R. Buck 45375* (NY). **NEBRASKA.** KEYA PAHA CO.: 3 mi N Riverview, 16.vi.1948, on bark, *W. Kiener 23706* (NY). NEMAHA CO.: Peru, 6.x.1899, on soil, *J.L. Sheldon s.n.* (NY). **NEW JERSEY.** ATLANTIC CO.: Tuckahoe Wildlife Management Area, gravel road .05 mi E of jct w/ Griscom Mill Rd., 2.xii.2009, on *Quercus*, *J.C. Lendemer 20043* (NY). CAPE MAY CO.: Peaslee Wildlife Management Area, ~3.75 mi W of jct NJ 49 & CR 548 (Weatherby Rd.), 2.ii.2009, on concrete, *J.C. Lendemer 15187* (NY). GLOUCESTER CO.: Glassboro Wildlife Management Area, ~1.5 mi S of jct NJ 322 and CR 655 (Fries Mill Rd.), on *Quercus*, *J.C. Lendemer 15305* (NY). MONMOUTH CO.: Allaire State Park, S corner between Squankum Rd. and Hospital Rd., 5.ii.2009, on *Quercus*, *J.C. Lendemer 15430* (NY). OCEAN CO.: Manahawkin Wildlife Management Area, S of Stafford Ave., 2.xii.2009, on *Quercus*, *J.C. Lendemer 20051* (NY). **NEW HAMPSHIRE.** CARROLL CO.: Moultonboro, Ossipee Mountains, Bald Knob Trail, 15.ix.2007, on soil, *M. Schmull s.n.* (FH). **NEW MEXICO.** EDDY CO.: Guadalupe Mountains, near end of FSR 540 in uppermost branch of Big Canyon, 7.vii.2010, on shaded limestone, *R.D. Worthington 36143* (NY, UTEP). SAN MIGUEL CO.: Pagosa Canyon just NE of McAllister Lake, 15.ix.1973, [on rock], *W.A. Weber et al. s.n. [L-57867]* (COLO). SOCORRO CO.: Gallinas Canyon, Los Negas [sic], 3.vii.1934, on rock, *R.A. Studhalter 51815* (NY). **NEW YORK.** DUTCHESS CO.: Dover Plains, Nellie Hill Preserve, 27.v.2007, on base of *Cornus, J.C. Lendemer 12057 & W.R. Buck* (NY). ESSEX CO.: SW side of Chapel Pond, 18.ix.2004, on shaded, vertical rock face, *J.C. Lendemer et al. 2969* (NY). GREENE CO.: Town of Hunter, Catskill Forest Preserve, Stony Clove Notch, 13.ix.2008, on rock, in overhang, *J.C. Lendemer 14091* (NY). HERKIMER CO.: Little Falls, Moss Island, 14.vi.2011, on rock, *R.C. Harris 56825* (NY). ONTARIO CO.: 3.4 mi N, 0.6 mi E Springwater, 25.xii.2003, on rock, *C.A. Morse 9976* (NY). ROCKLAND CO.: Bear Mountains State Park, Iona Island Bird Sanctuary, 18.vii.2010, on moss, in overhang, *J.C. Lendemer 23686 & A. Moroz* (NY). **NORTH CAROLINA.** CAMDEN CO.: Dismal Swamp State Park, S side of Corapeake Ditch, 10.x.2009, on *Acer*, *J.C. Lendemer 20133 & S. Williams* (NY). DARE CO.: Nags Head Woods Ecological Preserve, 29.ix.1993, on *Quercus*, *R.C. Harris 31024* (NY). JONES CO.: Croatan National Forest, Island Creek Walk, 17.iii.2003, on marl, *W.R. Buck 43735* (NY). HAYWOOD CO.: Great Smoky Mountains National Park, areas around Caldwell Fork, 4.viii.2009, on moss, in overhang, *J.C. Lendemer 18977 & E.A. Tripp* (NY). ORANGE CO.: Mason Farm Biological Reserve, Plot 5, 1.iii.2007, on *Acer rubrum*, *G.B. Perlmutter et al. 833* (NY). SWAIN CO.: Great Smoky Mountains National Park, Beauregard Ridge, 14.x.2010, on soil, *J.C. Lendemer et al. 26977* (NY). WILKES CO.: Stone Mountain State Park, ~8 mi SSW of Sparta, 23.ix.1993, on *Quercus*, *R.C. Harris 30801* (NY). **OHIO.** ADAMS CO.: Chaparral Prairie State Nature Preserve, 22.v.2006, on *Fraxinus*, *J.C. Lendemer et al. 7266* (NY). GALLIA CO.: Wayne National Forest, above Symmes Creek, 19.v.2006, on sandstone, *J.C. Lendemer et al. 7428* (NY). FAIRFIELD CO.: Sugar Grove, 1.vi.1918, on *Castanea*, *B. Fink 847* (FH). HAMILTON CO.: near Cheviot, 7.ix.1952, on *Quercus*, *W.L. Culberson 1055* (COLO). PIKE CO.: Strait Creek Prairie Preserve, 20.v.2006, on bryophytes, *W.R. Buck 50275* (NY).

SCIOTO CO.: Shawnee State Forest, at S jct of FR 3 & FR 6, 21.v.2006, on wood, *R.C. Harris 52750* (NY). **OKLAHOMA.** CHEROKEE CO.: 11 mi N of Hulbert, along Clear Creek, vi.2010, on *Quercus*, *V.P. Doyle 1078* (NY). MUSKOGEE CO.: Gruber Wildlife Management Area, along OK 10, 15.iv.2004, on rock, *R.C. Harris 49045* (NY). SEQUOYAH CO.: Sallisaw-Brushy Lake State Park, ~6 mi N of Sallisaw, 1.xi.2000, on rock, *W.R. Buck 38666* (NY). **OREGON.** COOS CO.: South Slough National Estuarine Research Reserve, 12 km SW of town of Coos Bay, ix.2008, on bark, *B. McCune 29774* (NY, OSC). LINCOLN CO.: Oregon Coast Trail just S of Cape Perpetua, 18.viii.2009, on soil bank, *B. McCune 30200* (NY). **PENNSYLVANIA.** CENTRE CO.: Bald Eagle State Forest, Stover Gap, 14.ix.2010, on *Quercus*, *J.C. Lendemer 25524* (NY). JEFFERSON CO.: Clear Creek State Park, Phyllis Run 0.25–0.75 mi N of confluence w/ Clear Creek, 8.ix.2010, on *Acer*, *J.C. Lendemer 24774* (NY). MONROE CO.: Tannersville Bog TNC Preserve, 24.xi.2009, on *Acer*, *J.C. Lendemer 19874 & V.P. Doyle* (NY). SULLIVAN CO.: Ricketts Glen State Park, S slope above Big Run, 19.ix.2010, on rock, in overhang, *J.C. Lendemer 25655 & J. Kunsman* (NY). UNION CO.: Bald Eagle State Forest, N-facing slopes above Spruce Run, 13.ix.2010, on *Quercus*, *J.C. Lendemer 25379* (NY). **SOUTH CAROLINA.** AIKEN CO.: The Hitchcock Woods, just SW of city of Aiken, along Tea Cottage Path from entrance on Dibble Rd., 14.iii.2010, on *Ilex*, *J.C. Lendemer 22048* (NY). EDGEFIELD CO.: Sumter National Forest, along FSR 634, 1.3 mi W of SC 52, 17.iii.1997, on *Carpinus*, *R.C. Harris 40283* (NY). McCORMICK CO.: Sumter National Forest, Stevens Creek Heritage Preserve, 11.iii.2010, on *Carya*, *R.C. Harris 55882* (NY). PICKENS CO.: along Eastatoe Creek, ~2.5 mi SW of town of Rocky Bottom, 27.ix.1989, on soil, *R.C. Harris 24782* (NY). **SOUTH DAKOTA.** CUSTER CO.: south of Jewel Cave National Monument, 0.8 mi S of US 16 in Hell Canyon, 6.vii.1960, on rock, *C.M. Wetmore 6924* (MSC). FALL RIVER CO.: TNC Whitney Preserve, Alabaugh Canyon, 3.vii.2007, on *Junipers*, *M.K. Advaita 6443* (NY). LAWRENCE CO.: Town of Whitewood (9 mi NE of Lead), 10.viii.1961, on rock, *C.M. Wetmore 11186* (MSC). PENNINGTON CO.: 3.3 mi W of Canyon Lake on Rim Rock Drive, 31.vii.1960, on rock, *C.M. Wetmore 8626* (NY). **TENNESSEE.** BLOUNT CO.: Great Smoky Mountains National Park, White Oak Sinks, manhole to blowhole, 13.x.2010, on limestone, *J.C. Lendemer et al. 1462* (NY). MONROE CO.: Cherokee National Forest, Bald River Falls Quad., along Laurel Creek between SR 165 and FSR 35, 6.viii.1994, on soil, *R.C. Harris 32888* (NY). POLK CO.: Cherokee National Forest, along FSR 62 at Sheeds Creek, 5.x.1998, on *Liriodendron*, *R.C. Harris 42486* (NY). SEVIER CO.: Great Smoky Mountains National Park, summit of the Chimney Tops, 28.vi.2010, on rock, in overhang, *J.C. Lendemer et al. 23336* (NY). **TEXAS.** EL PASO CO.: Franklin Mountains, 1.0 air mi S top of North Franklin Mountain, 22.ii.1981, on soil, *R.D. Worthington 6863* (COLO, UTEP). **UTAH.** UINTAH CO.: Ashley National Forest, along FSR 104 (Paradise Park Rd.), vicinity of Weasel Point, 30.vii.2009, on bryophytes, *W.R. Buck 55066* (NY). **VERMONT.** ADDISON CO.: Town of Bristol, Green Mountain National Forest, Bristol Cliffs Wilderness Area, 20.x.2010, on humus, in overhang, *J.C. Lendemer 27391 & M. Sundue* (NY). CHITTENDEN CO.: City of Burlington, Lone Rock Point, 17.x.2010, on *Thuja*, *J.C. Lendemer et al. 27037* (NY). ESSEX CO.: Town of Victory, Victory State Forest, Umpire Mountain, 16.v.2008, on rock, *R.C. Harris 54384* (NY). LAMOILLE CO.: Town of Eden, Babcock Nature Preserve of Johnson State College, 14.v.2005, on *Betula*, *R.C. Harris 51378* (NY). **VIRGINIA.** CHESAPEAKE CITY: Dismal Swamp National Wildlife Refuge, E of Laurel Ditch, 13.xii.2009, on *Magnolia*, *J.C. Lendemer et al. 20562* (NY). GRAYSON CO.: Jefferson National Forest, ~0.5 mi SW of VA 16 on VA 741/Homestead Rd., 5.iv.2008, on *Acer*, *R.C. Harris 54046* (NY). MANASSAS CITY: Manassas, iv.1923, on rock, *S. Chapman 2121* (FH). PAGE CO.: Shenandoah National Park, Big Meadows, 12.viii.1966, on *Quercus*, *I.M. Brodo 9409* (COLO, MSC). SMYTH CO.: Jefferson National Forest, Whitetop Mountain, 5.iv.2008, on rock, *R.C. Harris 54110* (NY). SUFFOLK CITY: Dismal Swamp National Wildlife Refuge, Jericho Ditch, 12.xii.2009, on *Acer*, *J.C. Lendemer 20489 & B.P. Hodkinson* (NY). **WASHINGTON.** CLALLAM CO.: Olympic National Park, Ozette Lake N, 6.iv.1999, on *Alnus*, *T. Tønsberg 27047* (FH). **WEST VIRGINIA.** GRANT CO.: Greenland Gap, along CR3-3, 21.ix.2001, on bryophytes, *R.C. Harris 44847* (NY). PENDLETON CO.: Monongahela National Forest, along Smoke Hole Rd. (CR 2), 2.x.2000, on rock, *R.C. Harris 44077* (NY). POCAHONTAS CO.: Watoga State Park, Pyle Mountain vic. picnic area at north entrance, 21.x.2007, on *Carya*, *J.C. Lendemer 9836 & A. Moroz* (NY). TUCKER CO.: Monongahela National Forest, Olsen's Bog, 22.ix.2001, on *Betula*, *R.C. Harris 44870* (NY). **WISCONSIN.** LINCOLN CO.: Town of Rock Falls, along E shore of Wisconsin River at Grandfather Dam, 27.iv.2002, on soil, *R.C. Harris 45876* (NY). ONEIDA CO.: Town of Minocqua, Patters Hemlocks State Natural Area, 29.iv.2002, on *Betula*, *R.C. Harris 46004* (NY). RICHLAND CO.: Bosstown, 24.ix.1958, on rock, *T. Ahti 5008* (H, NY). SAUK CO.: Baraboo Hills, Hemlock Draw Preserve, 4.ix.1998, on sandstone, *R.C. Harris 42204* (NY). VILAS CO.:

Town of Plum Lake, Northern Highland State Forest, N of Co. Hwy. K just E of Old K Rd., 26.iv.2002, on *Betula*, *R.C. Harris 45832* (NY). **WYOMING.** CAMPBELL CO.: Rochelle Hills, head of Wildcat and S Fork Keyton Creeks, 5-8.vi.1975, on rock, *W.R. Weber L-81816* (COLO).

8) *Lepraria friabilis* Lendemer, K. Knudsen & Elix, Opuscula Philolichenum 5: 64. 2008. TYPE: **U.S.A. ALABAMA.** BALDWIN CO.: Splinter Hill Bog Preserve, south of CR 47, 0.8 mi NW of Dyas Creek, 1.3 mi WNW of I-65, 250 ft., *Sarracenia* bog with adjacent hardwood swamp and bottomlands along stream, 12.iv.2007, on *Pinus*, *J.C. Lendemer et al. 9063* (NY!, holotype; B!, CANB!, UCR!, UGDA!, hb. Lendemer!, isotypes).

FIGURES 21 AND 22.

Description. – **Thallus** crustose, leprose, aggregated, discontinuous and not stratified, initially composed of isolated granules that divide to form aggregations, eventually merging to form a thin crust (<0.1 mm thick), gray-blue in color; **hyphae** hyaline, [1.5]–(2.2)–2.8–(3.4)–[4.3] µm (*n*=96) in width, septate, secund, obscured by a thick layer of POL+ crystals that dissolve in KOH; **prothallus** persistent; **hypothallus** absent; **rhizohyphae** absent; **granules** globose, [24]–(32)–42–(52)–[66] µm (*n*=128) in diameter, ecorticate, well organized and discrete, remaining distinct and not forming compound units; **photobiont** green, coccoid, cells globose, [4.8]–(6.9)–8.9–(11.0)–[15.6] µm (*n*=90) in width.

Chemistry. – Fumarprotocetraric acid, protocetraric acid, ± atranorin. Spot tests: K-, C-, KC-, P+ orange-red, UV-.

When *Lepraria friabilis* was described it was considered to include only populations with fumarprotocetraric acid as the major substance (Lendemer et al. 2008). Subsequent study led to the discovery of several additional populations in eastern North America that produced atranorin. Inclusion of one such population in molecular phylogenetic analyses that included a diverse sampling of *L. friabilis* did not reject the inclusion of this chemotype in the species (Lendemer 2012a). It should be noted that *L. friabilis* often occurs in mixed populations with *L. harrisiana*, and TLC results that show the presence of zeorin and/or fatty acids should be evaluated in this light.

Lendemer et al. (2008) also noted the existence of a second chemotype that produced only fumarprotocetraric acid and was restricted to southern California. Subsequent study has shown the vouchers of this chemotype represent a sterile sorediate crust unrelated to *Lepraria* s.str. The thalli in this material superficially appear to be leprose, but are in fact comprised of a mostly endosubstratal crust that develops minute irregular areoles which quickly erupt into soralia (figure 20). The morphology of this species is very similar to that of *Lecanora nothocaesiella*, which differs chemically in the production of atranorin and zeorin (Lendemer et al. 2013).

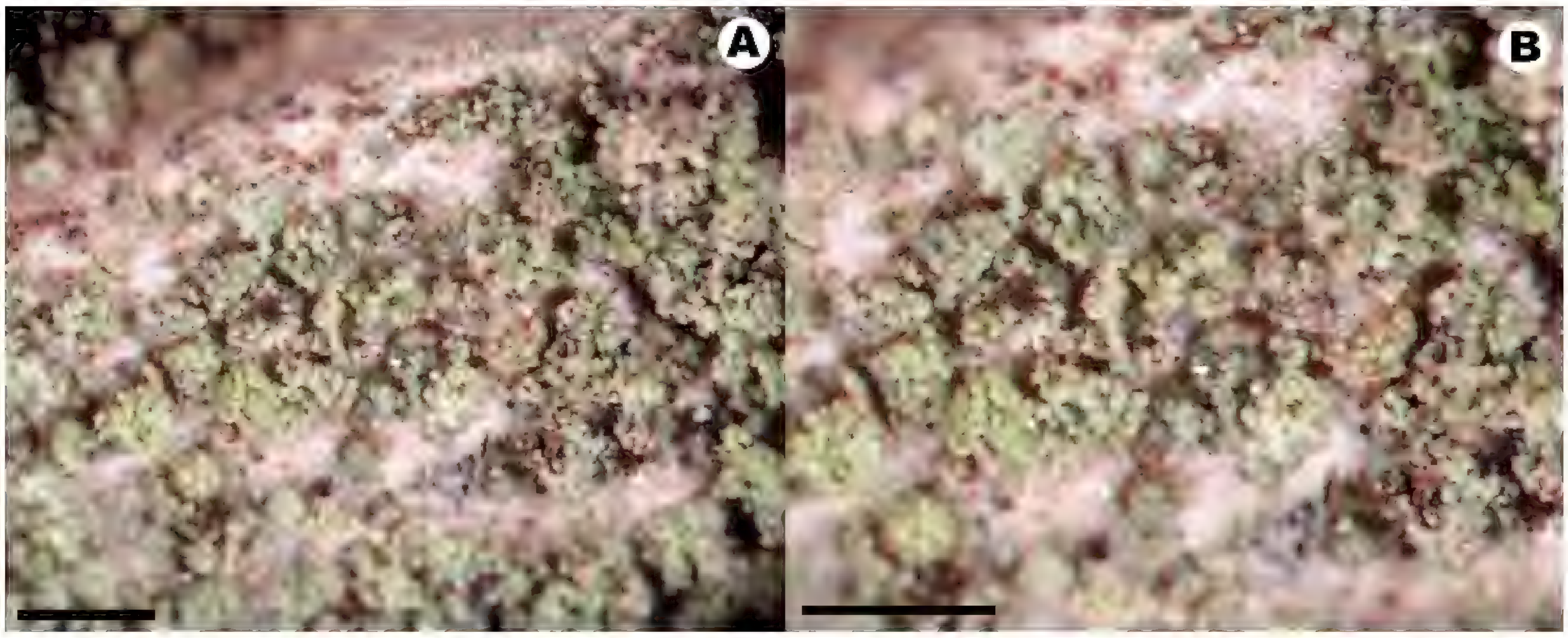

Figure 20, unidentified sterile sorediate crust previously confused with *Lepraria friabilis* and originally included within that taxon as a second chemotype known only from two localities in California (both from *Knudsen 9205*, NY; scales = 0.5 mm).

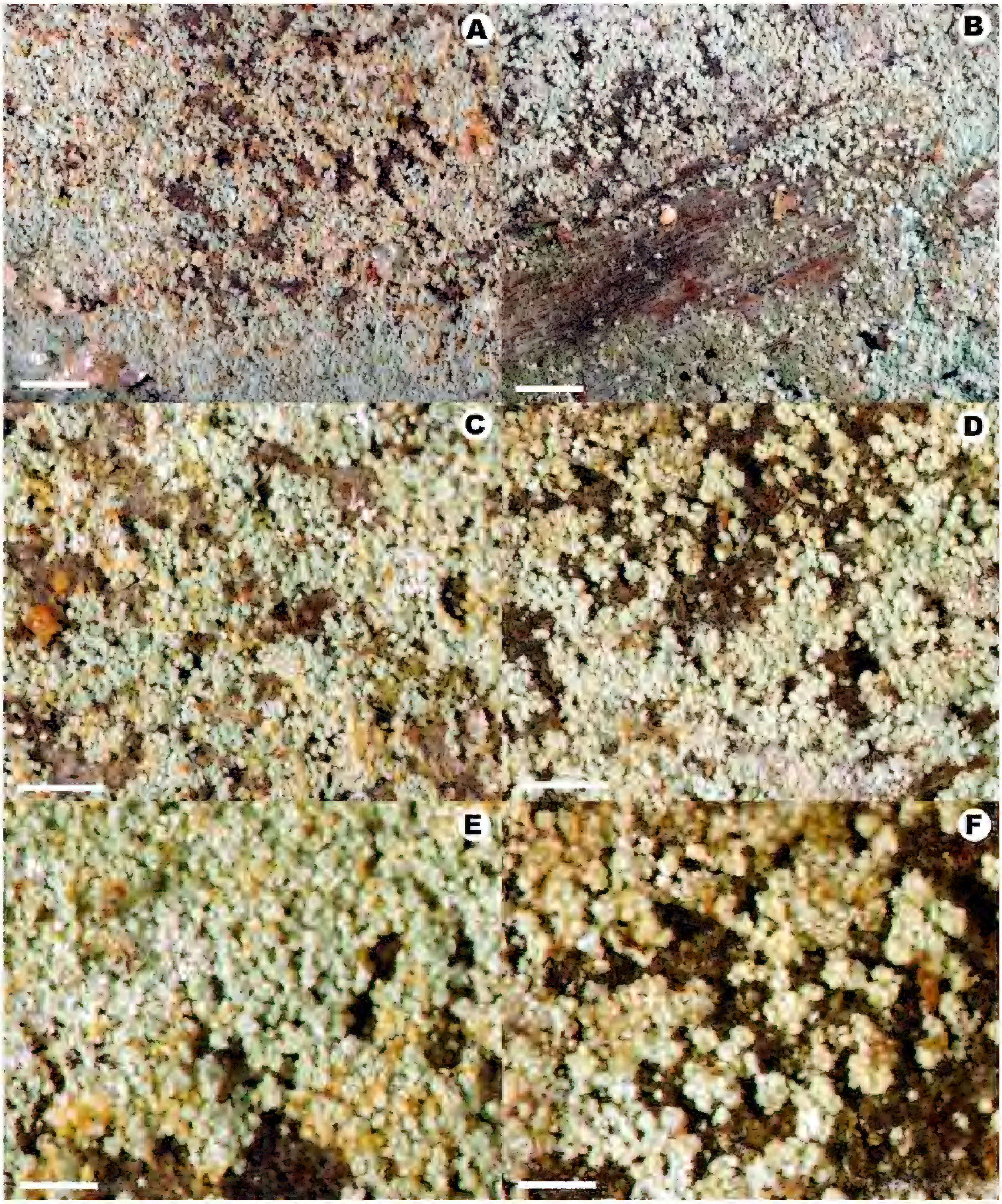

Figure 21, *Lepraria friabilis* (*Lendemer 21079A* is left; *Lendemer 21344* is right). A–B, gross morphology of the thallus (scales = 1.0 mm). C–D, detail of the thallus (scales = 0.5 mm). E–F, detail of the granules (scales = 0.25 mm).

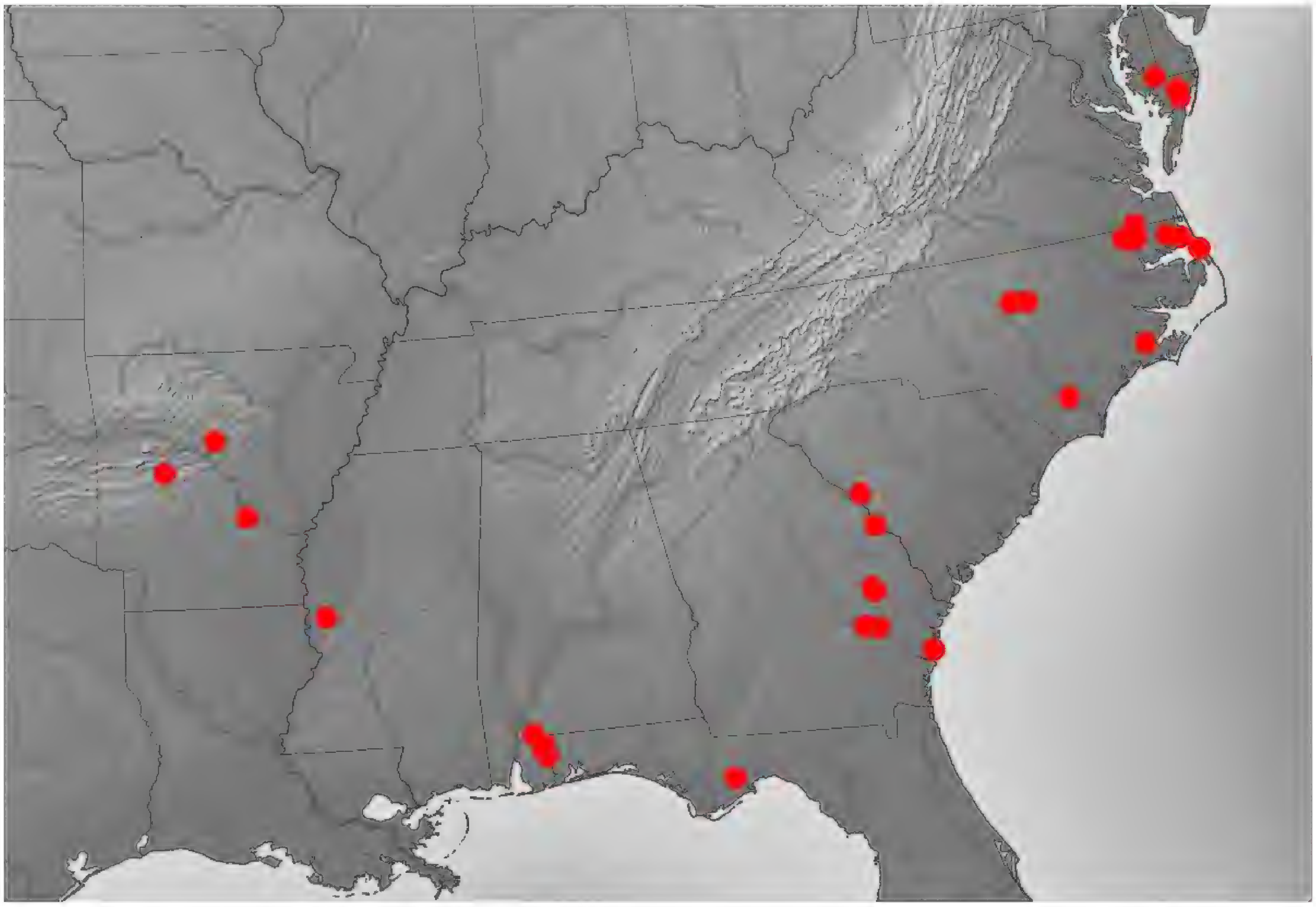

Figure 22, geographic distribution of *Lepraria friabilis* based on the specimens examined for this study.

Ecology and distribution. – *Lepraria friabilis* is widespread throughout the subtropical regions of the Coastal Plain of southeastern North America (figure 22). The species is common in freshwater wetlands, particularly swamps, where it typically occurs on the bark of conifers. This taxon is likely more widespread than the available collections indicate and further studies are needed to fully elucidate its geographic distribution.

Conservation status. – This species is locally abundant in, and endemic to, freshwater wetlands throughout the subtropical portions of the Coastal Plain in southeastern North America. Its apparent restriction to these habitats, which are under mounting threat from a myriad of forces including climate change and anthropogenic habitat alteration, indicates that the conservation needs of this species require further study.

Discussion. – There are relatively few species of *Lepraria* sympatric with *L. friabilis* and as such there is likely little chance for confusion. The species often occurs with *L. finkii* and *L. harrisiana*, sometimes as mixed populations. Both of those species have placodioid rather than aggregate thalli, and thus only populations of *L. friabilis* where the aggregate thalli have fused to form a continuous crust are likely to be misidentified. Those species are also chemically distinct in producing atranorin and zeorin (with accessory pallidic acid in *L. harrisiana* and stictic acid in *L. finkii*). As has been noted above in the chemistry section, TLC analyses of *L. friabilis* specimens that reveal the presence of zeorin or fatty acids are almost certainly the result of admixtures of *L. harrisiana*. *Lepraria aurescens* and *L. squamatica* could also be confused with *L. friabilis* if one does not notice the different thallus type (placodioid in those species). However, *L. aurescens* produces thamnolic acid and *L. squamatica* produces squamatic acid (note, the latter also produces protocetraric acid as an accessory to squamatic acid).

When Lendemer et al. (2008) described *Lepraria friabilis* they questioned whether the species was sympatric with *L. caesiella*, which they considered to be morphologically similar in producing an aggregate thallus. Subsequent study of *L. caesiella* revealed that the populations that were sympatric with *L. friabilis* actually represented a new species, *L. harrisiana*, which has a placodioid rather than aggregate thallus

(Lendemer 2012a). Surprisingly, no other *Lepraria* species with aggregate thalli are sympatric with *L. friabilis*. Corticolous populations of the fumarprotocetraric acid producing-chemotype of *L. neglecta* are most likely to be confused with *L. friabilis*. However, the granules of *L. neglecta* produce a well-developed pseudocortex and thus appear compact (vs. ecorticate and fuzzy in *L. friabilis*).

Selected specimens examined (35 total seen from North America; specimens with atranorin are indicated with at+). – **U.S.A. ALABAMA.** BALDWIN CO.: Perdido River Wildlife Management Area, 2.5 mi N of CR 112, 11.iv.2007, on *Chamaecyparis*, *R.C. Harris 53245* (NY). **ARKANSAS.** FAULKNER CO.: Cove Creek Natural Area, 7.x.2010, on *Pinus*, *J.C. Lendemer et al. 26202* (NY). JEFFERSON CO.: Pine Bluff Arsenal, along S side of Arkansas River, 1.xii.1999, on *Taxodium*, *D. Ladd 21852 & M. Pederson* (NY), *D. Ladd 22032 & M. Pederson* (NY, at+). PERRY CO.: Ouachita National Forest, vicinity of Goat Bluff along N side of South Fourche LaFave River, 6.x.2010, on *Pinus*, *J.C. Lendemer et al. 26011* (NY, at+). **FLORIDA.** ESCAMBIA CO.: along CR 99A at Brushy Creek, 4.3 mi W of SR 97 at Walnut Hill, 8.xii.1993, on *Taxodium, R.C. Harris 31922* (NY). WAKULLA CO.: Apalachicola National Forest, Bradwell Bay Wilderness, along Apalachicola Trail at Sopchoppy River, 29.xi.1988, on bark, *R.C. Harris 22994* (NY). **GEORGIA.** APPLING CO.: Moody Forest Natural Area, 0–0.5 mi E of head of River Trail on Miller Landing Rd., 17.xii.2009, on *Pinus*, *J.C. Lendemer 21079-A* (NY). BURKE CO.: Boggy Gut Creek tract, N of GA 56 Spur (River Rd.), 15.iii.2010, on *Pinus*, *J.C. Lendemer 22248-A* (NY). CANDLER CO.: Charles Harold TNC Preserve, 0–0.25 mi N of Salem Church Rd., 22.xii.2009, on *Pinus*, *J.C. Lendemer et al. 21784* (NY). McINTOSH CO.: Sapelo Island, Sapelo Island Wildlife Management Area, Dogpatch Rd. ¾ mi E of Lumber Landing, 15.xii.2009, on *Pinus*, *J.C. Lendemer 20653* (NY). TATTNALL CO.: Big Hammock Natural Area, 0.25 mi W of parking area on CR 441, 20.xii.2009, on *Taxodium*, *J.C. Lendemer 21344 & S.Q. Beeching* (NY). **MARYLAND.** WORCESTER CO.: Pocomoke State Forest, along Corbin Branch where it enters the Pocomoke River, 19.iv.2006, on *Taxodium*, *J.C. Lendemer et al. 6415* (NY). **MISSISSIPPI.** SHARKEY CO.: Delta National Forest, near Lost Lake, 23.vi.1978, on *Taxodium*, *G.T. Johnson 7104* (NY, at+). **NORTH CAROLINA.** BLADEN CO.: N of Elwell Ferry Rd., ~0.5 mi W of Elwell Ferry, 15.vi.2002, on *Taxodium*, *R.C. Harris 46078* (NY). CRAVEN CO.: Croatan National Forest, N of Havelock, W of SR 70, W of Flanners Beach Campground, 13.xii.2004, on *Pinus*, *J.C. Lendemer 4217 & E.A. Tripp* (NY). GATES CO.: Merchants Millpond State Park, Coleman Trail 0–1 mi SE of Boat Launch Parking Area, 11.xii.2009, on *Fagus*, *J.C. Lendemer 20283 & F. Williams* (NY). ORANGE CO.: Mason Farm Biological Reserve, Big Oak Woods, 26.vii.2007, on *Pinus*, *G.B. Perlmutter 1100* (NY). WAKE CO.: Umstead State Park, Sycamore Lake area, 14.i.2007, on *Pinus*, *G.B. Perlmutter 794 & J.C. Lendemer* (NCU, NY). **SOUTH CAROLINA.** EDGEFIELD CO.: Sumter National Forest, along FSR 634, 1.3 mi W of SC 52, 17.iii.1997, on *Pinus*, *R.C. Harris 40277* (NY).

9) *Lepraria harrisiana* Lendemer, Castanea 77: 94. 2012. TYPE: **U.S.A. NORTH CAROLINA.** CAMDEN CO.: Dismal Swamp State Park, S side of Kim Saunders Ditch, at 5 mi marker, Atlantic white cedar (*Chamaecyparis thyoides*) stand with blow-downs and mixed hardwoods (*Magnolia, Acer, Nyssa*), 10.xii.2009, on *Chamaecyparis*, *J.C. Lendemer 20191 & S. Williams* (NY!, holotype).

FIGURES 23 AND 24.

Description. – **Thallus** crustose, leprose, placodioid, continuous and typically distinctly bi-layered, initially forming small discrete thalli which expand marginally, overlap and become confluent to form a thick crust (0.2–0.4 mm thick), light greenish-blue in color, often with a slightly yellowish hue as the thallus ages in the herbarium; **hyphae** hyaline, [1.2]–(2.2)–2.9–(3.5)–[4.8] µm (*n*=68) in width, septate, secund, obscured by a thick layer of POL+ crystals that dissolve in KOH; **prothallus** disappearing with age; **hypothallus** a thin, often poorly developed layer of loosely intertwined hyphae surrounding and subtending the granules, extending outward from the edge of the thallus; **rhizohyphae** present, pale to dirty brownish; **granules** globose, [19]–(27)–38–(48) –[72] µm (*n*=124) in diameter, ecorticate, well organized and discrete, often forming compound units of multiple granules; **photobiont** green, coccoid, cells globose, [6]–(7.8)–9.6–(11.4)–[14.4] µm (*n*=97) in diameter.

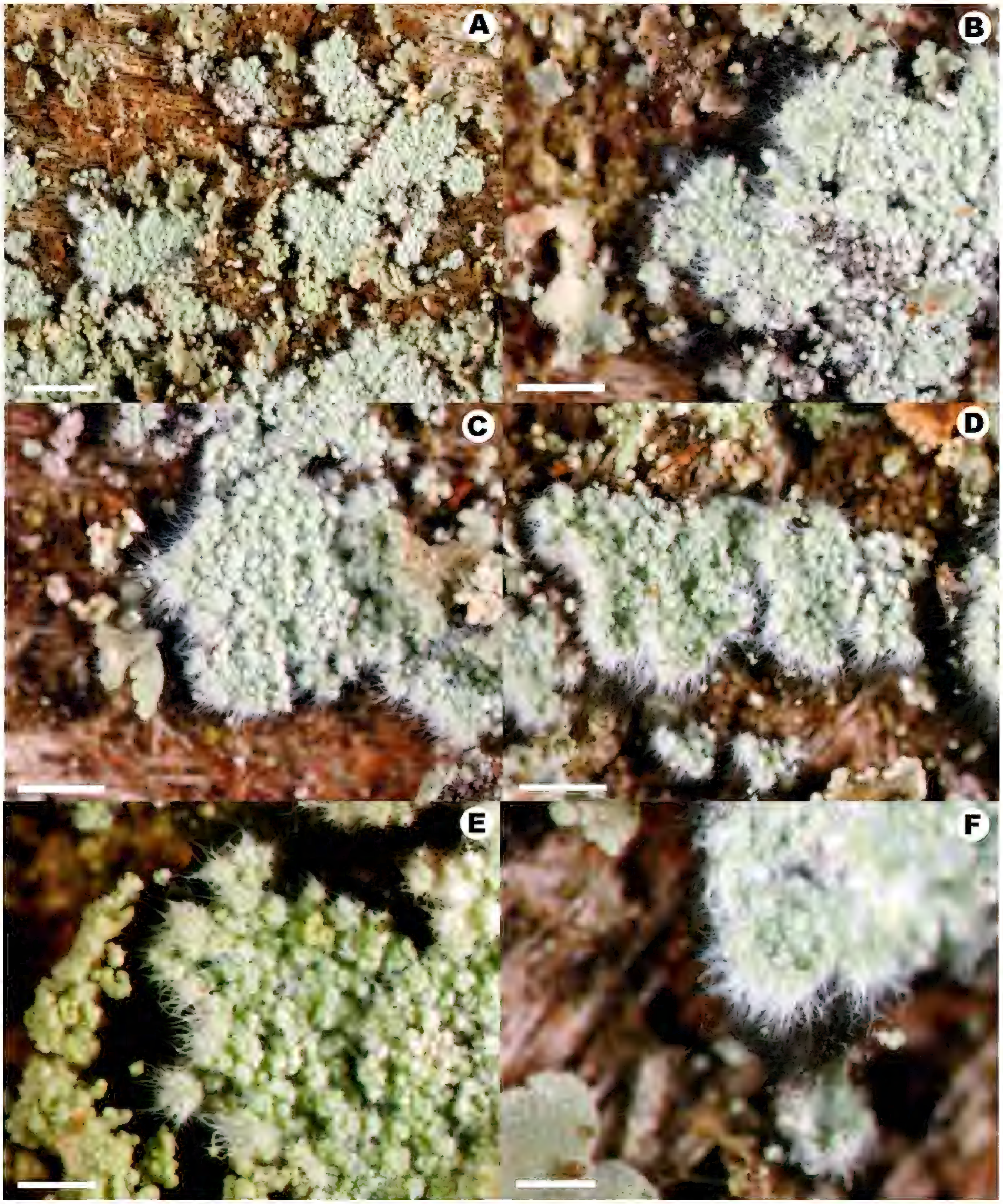

Figure 23, *Lepraria harrisiana* (all from *Lendemer 55730*). A, gross morphology of the thallus (scale = 1.0 mm). B–D, detail of the thallus, and thallus surface (scales = 0.5 mm). E–F, detail of the thallus edge, illustrating rhizohyphae and ascending margins (scales = 0.25 mm).

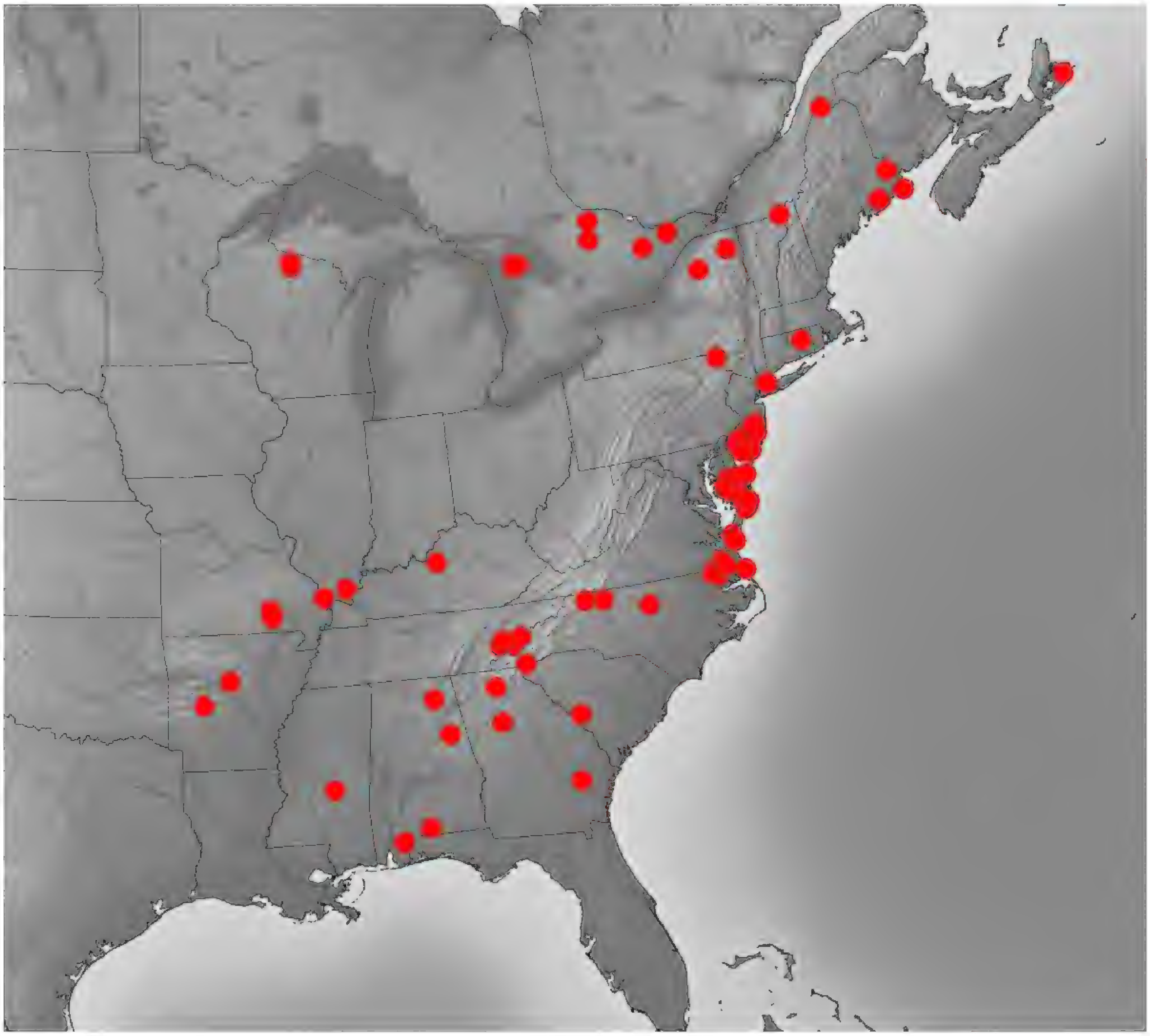

Figure 24, geographic distribution of *Lepraria harrisiana* based on the specimens examined for this study.

Chemistry. – Atranorin, zeorin, pallidic acid. Spot tests: K+ yellow, C-, KC-, P+ weak yellow, UV-.

Ecology and distribution. – *Lepraria harrisiana* is widespread in eastern North America (figure 24) where it occurs in high humidity habitats, particularly those associated with bodies of water. It is widely distributed in conifer swamps and riparian forests throughout both the Gulf and Atlantic coastal plains of southeastern North America, occurring from Massachusetts to Georgia and westward to at least Alabama. Disjunct populations also occur at high elevations of the southern Appalachian Mountains, riparian conifer forests along the edges of the Ozarks and in the Ouachita Mountains, oceanic forests of the Canadian Maritimes, and conifer swamps of the Great Lakes Region. As geographically disparate as this distribution may appear, it is not illogical considering the recent biogeographic patterns outlined by Lendemer et al. (2013) for other lichens that occur in the southern Appalachian Mountains. Interestingly, saxicolous populations of *L. harrisiana* have not been encountered and the majority of the collections are from coniferous hosts (*Picea*, *Pinus*, *Thuja*, especially *Chamaecyparis*). Whereas the chemically similar *L. caesiella* rarely occurs on conifers, and rather is most often found on the bark of hardwoods and on non-calcareous rocks.

Conservation status. – The status of *Lepraria harrisiana* is somewhat similar to that of *L. friabilis*, although *L. harrisiana* is more widespread. The populations of *L. harrisiana* in the southeastern Coastal Plain are more-or-less restricted to freshwater wetlands, and thus threatened by the ecosystem-wide changes predicted to occur in those habitats as a result of global climate change. The populations in the Appalachian Mountains mostly occur at higher elevations, and the species is particularly abundant in the endemic spruce-fir forests of the southern Appalachians. These habitats are also under significant pressure from a diverse array of forces (Lendemer et al. 2013). The species also occurs on conifers in the Canadian Maritimes and Great Lakes regions. These populations are likely the least threatened of the species, but could be negatively impacted by forest management policies that result in the culling of too many trees and alter long-term moisture regimes.

Discussion. – *Lepraria harrisiana* was initially included within a broadly circumscribed *L. caesiella* until molecular phylogenetic analyses of nuITS sequence data confirmed that the significant differences in thallus morphology warranted taxonomic recognition (Lendemer 2012a). Both species have the same chemical profile but express the two fundamentally different types of leprarioid thalli outlined by Lendemer (2011a). The thallus in *L. harrisiana* is placodioid and of the *cryophila*-type (i.e., with a hypothallus composed of loosely intertwined hyphae) whereas that of *L. caesiella* is aggregate and of the *caesiella*-type.

Morphologically *Lepraria harrisiana* is most similar to *L. aurescens* and *L. squamatica* both of which also occur in southeastern North America. The two species are easily distinguished chemically by the production of thamnolic acid in *L. aurescens* and squamatic acid in *L. squamatica.* Harris (*in* Lendemer 2005) compared *L. harrisiana* to *L. rigidula*. That species has an aggregate thallus and differs in producing nephrosteranic acid rather than zeorin and pallidic acid.

Selected specimens examined (93 total seen from North America). – **CANADA. NEW BRUNSWICK.** CHARLOTTE CO.: Grand Falls Flowage on St. Croix River, 20.iv.2011, on *Tsuga*, *J.C. Lendemer 27854* (NY), on *Betula*, *J.C. Lendemer 27786* (NY). **NOVA SCOTIA.** INVERNESS CO.: Trout Brook Wilderness Area, 27.vii.2000, on *Betula*, *S. Selva et al. 8839A* (UMFK). **ONTARIO.** BRUCE CO.: Bruce Peninsula National Park, 20.ix.2008, on *Pinus*, *J.C. Lendemer 14283* (NY). FRONTENAC CO.: Arcol Road, 24.ii.2011, on *Pinus*, *C. Lewis 508* (NY). NIPISSING DIST.: Algonqiun Provincial Park, SE corner of Carl Wilson Lake, 31.vii.2011, on stump, *I.M. Brodo et al. 33035* (CANL). OTTAWA-CARLTON CO.: City of Ottawa, Stony Swamp, 19.v.2011, on *Thuja*, *J.C. Lendemer 28152 & I.M. Brodo* (NY). **U.S.A. ALABAMA.** CLAY CO.: Cheaha State Park, 24.ix.1992, on *Pinus*, *R.C. Harris 28298* (NY). COVINGTON CO.: Conecuh National Forest, Solon Dixon Forestry Education Center, 14.iv.2007, on *Pinus*, *J.C. Lendemer et al. 9430* (NY). MARSHALL CO.: Lake Guntersville State Park, 13.viii.2005, on *Pinus*, *J.C. Lendemer 4872* (NY). **ARKANSAS.** FAULKNER CO.: Cove Creek Natural Area, 7.x.2010, on *Pinus*, *J.C. Lendemer et al. 26201* (NY). GARLAND CO.: Ouachita National Forest, W side of North Fork Ouachita River, 6.x.2010, on *Pinus*, *J.C. Lendemer et al. 26116* (NY). **CONNECTICUT.** WINDHAM CO.: Town of Windham, Windham Bog, 20.ix.2009, on *Chamaecyparis*, *R.C. Harris 55730* (NY). **FLORIDA.** ESCAMBIA CO.: along CR 99a at Brushy Creek, 8.xii.1993, on *Taxodium*, *R.C. Harris 31907* (NY). SANTA ROSA CO.: Blackwater River State Forest, 9.xii.1993, on *Taxodium*, *R.C. Harris 32004* (NY). **GEORGIA.** DAWSON CO.: Amicalola Falls State Park, 21.xii.2009, on *Pinus*, *M.F. Hodges s.n.* (NY). ROCKDALE CO.: Panola Mountain State Park, 17.iv.2007, on *Pinus*, *J.C. Lendemer et al. 9002* (NY). TATNALL CO.: Big Hammock Natural Area, 20.xii.2009, on *Taxodium*, *J.C. Lendemer 21368 & S.Q. Beeching* (NY). **ILLINOIS.** ALEXANDER CO.: Shawnee National Forest, Grapevine Trail Picnic and Camping Area, 6.xi.2004, on *Pinus*, *R.C. Harris 50521* (NY). **KENTUCKY.** BULLITT CO.: Bernheim Arboreum and Research Forest, 28.iii.2002, on *Pinus*, *D. Ladd 23610 & M. Ladd* (NY). **MAINE.** HANCOCK CO.: T.10 SD, N of ME 182, 27.vii.2006, on *Tsuga*, *R.C. Harris 53071* (NY). WASHINGTON CO.: Town of Cutler, Cutler Coastal Public Lands, 8.vi.2010, on conifer, *J.C. Lendemer 22755* (NY). **MARYLAND.** CAROLINE CO.: Idylwild State Wildlife Management Area, 18.iv.2006, on *Acer*, *J.C. Lendemer 6226 & W. Knapp* (NY). WICOMICO CO.: Sharptown Dunes, 19.iv.2006, on *Quercus*, *J.C. Lendemer et al 6291* (NY). **MISSISSIPPI.** SCOTT CO.: Bienville National Forest, Bienville Pines Scenic Area, 29.ix.1992, on *Pinus*, *R.C. Harris 28713* (NY). **MISSOURI.** CARTER CO.: Mark Twain National Forest, vicinity of Big Barren Creek Natural Area, 9.x.2010, on *Pinus*, *J.C. Lendemer 26576 & D. Ladd* (NY). **NEW JERSEY.** ATLANTIC CO.: Wharton State Forest, Batsto Natural Area, 15.iii.2000, on *Chamaecyparis*, *R.C. Harris 43787* (NY). BURLINGTON CO.: Wharton State Forest, W shore of Batsto River, 13.xi.2004, on *Pinus*, *J.C. Lendemer 3522 & R.F. Lendemer* (NY). CAMDEN CO.: Wharton State Forest, 0–0.5 mi W of CR 536 (Chew Rd.), 6.ii.2009, on *Pinus*, *J.C. Lendemer 15477* (NY). CAPE MAY CO.: Peaslee Wildlife Management Area, 2.ii.2009, on *Chamaecyparis*, *J.C. Lendemer 15208* (NY). CUMBERLAND CO.: Peaslee Wildlife Management Area, 2.ii.2009, on log, *J.C. Lendemer 15116* (NY). GLOUCESTER CO.: Glassboro Wildlife Management Area, 4.ii.2009, on *Quercus*, *J.C. Lendemer 15302* (NY). OCEAN CO.: Manchester Wildlife Management Area, 5.ii.2009, on *Gaylussacia*, *J.C. Lendemer 15366* (NY). SALEM CO.: Parvin State Park, 26.xii.2008, on *Pinus*, *J.C. Lendemer et al. 15018* (NY). **NEW YORK.** SUFFOLK CO.: Cranberry Bog Nature Preserve, 20.ix.1986, on *Chamaecyparis*, *R.C. Harris 19438-B* (NY). ST. LAWRENCE CO.: Twin Lakes, 6.ix.1981, on *Tsuga*, *R.C. Harris 13900* (NY). **NORTH CAROLINA.** ORANGE CO.: Johnston Mill Nature Preserve, 7.iii.2009, on *Pinus*, *G.B. Perlmutter et al. 1690* (NY). MACON CO.: Sunset Rocks, Highlands, 9.vi.1981, on *Pinus*, *R.C. Harris 13658* (NY). SURRY CO.: Pilot Mountain State Park, 26.viii.2006, on *Pinus*, *G.B. Perlmutter 587 & J. Pearson* (NY). TRANSYLVANIA CO.: Gorges State Park, 9.viii.2005, on *Pinus*, *J.C. Lendemer 4617 & E.A. Tripp* (NY). WILKES CO.: Stone Mountain State Park, 23.ix.1993, on *Pinus*, *R.C. Harris 30793* (NY). **PENNSYLVANIA.** WAYNE CO.: Dripping Cliffs TNC Preserve, 2.vii.2008, on *Tsuga*, *J.C. Lendemer 12373* (NY). **SOUTH CAROLINA.** AIKEN CO.: The Hitchcock Woods, 14.iii.2010, on *Pinus*, *J.C. Lendemer 22069* (NY). McCORMICK CO.: Sumter National Forest, Stevens Creek Heritage Preserve, 11.iii.2010, on *Pinus*, *R.C. Harris 55848* (NY). **TENNESSEE.** BLOUNT CO.: GSMNP, Rich Mountain Gap at Ace Gap Trail, 30.vi.2010, on *Pinus*, *J.C. Lendemer et al. 23601* (NY). COCKE CO.: GSMNP, Gabes Mountain Trail, 5.viii.2009, on *Tsuga*, *E.A. Trip 656 & J.C. Lendemer* (NY). SEVIER CO.: GSMNP, Chimney Tops Trail, 28.vi.2010, on *Betula*, *J.C. Lendemer et al. 23372* (NY). **VERMONT.** ESSEX CO.: Town of Averill, Quimby Country resort property, 19.v.2008, on *Abies*, *R.C. Harris 54600* (NY). **VIRGINIA.** CHESAPEAKE CITY: Dismal Swamp National Wildlife Refuge, E of Laurel Ditch, 13.xii.2009, on *Pinus*, *J.C. Lendemer et al. 20572* (NY). SUFFOLK CO.: Dismal Swamp National Wildlife Refuge, vicinity of canal bridge over Jerico Ditch, 12.xii.2009, on *Fagus*, *J.C. Lendemer 20437 & B.P. Hodkinson* (NY). **WISCONSIN.** ONEIDA CO.: Town of Woodruff, Northern Highland State Forest, 28.iv.2002, on *Tsuga*, *R.C. Harris 45954* (NY).

10) *Lepraria hodkinsoniana* Lendemer, Mycologia 103: 1224. 2011. TYPE: **U.S.A. NEW JERSEY.** ATLANTIC CO.: Wharton State Forest, E of Nesco, NW of Batsto, N of Pleasant Mills Cemetery, 3–10 m, mixed *Pinus rigida-Quercus* forest with sparse *Betula*, on *Quercus*, 24 Oct 2004, *J.C. Lendemer 3358 = Lich. East. N. Amer. Exs. IV: 185* (NY! [barcode-1232372], holotype; ASU!, B!, BG!, CANB!, CHR!, DOV!, FH!, GZU!, H!, M!, MIN!, NY! [barcode-1069104], S!, TNS!, TU!, UPS!, isotypes).

FIGURES 25 AND 26.

Description. – **Thallus** crustose, leprose, aggregated, discontinuous and not stratified, initially composed of isolated granules that divide to form aggregations, eventually merging to form a thin crust (<0.1 mm thick), greenish-blue in color; **hyphae** hyaline, [1.7]–(2.3)–3–(3.8)–[7] µm (*n*=180) in width, septate, secund, obscured by a thick layer of crystals that dissolve in KOH; **prothallus** persistent; **hypothallus** indistinct, poorly developed or absent; **rhizohyphae** absent; **granules** globose, [15]–(25)–33–41–[60] µm (*n*=180) in diameter, ecorticate initially and eventually forming a poorly developed pseudocortex, well organized and discrete; **photobiont** green, coccoid, cells globose, [5]–(6.8)–8.8–(10.9)–[16] µm (*n*=180) in diameter.

Chemistry. – Divaricatic acid, zeorin, ± atranorin, ± traces of nordivaricatic acid. Spot tests: K-, C-, KC- or very weakly KC+ pink, P-, UV+ blue-white.

Ecology and distribution. – *Lepraria hodkinsoniana* is restricted to eastern North America (figure 26) where it occurs primarily on the bark of hardwoods, especially *Acer* and *Quercus*. Occasionally the species has been found on conifers, and very rarely on non-calcareous rocks in habitats with high humidity. The species is most common in the Mid-Atlantic Coastal Plain, where it is frequently associated with *L. caesiella* in mesic upland hardwood forests. It is however widely distributed with populations throughout the Appalachian Mountains, the Ozark Ecoregion, and the Great Lakes Region. In many respects the distribution of this species mirrors that of *Punctelia caseana* Lendemer & Hodkinson (see Lendemer & Hodkinson 2010).

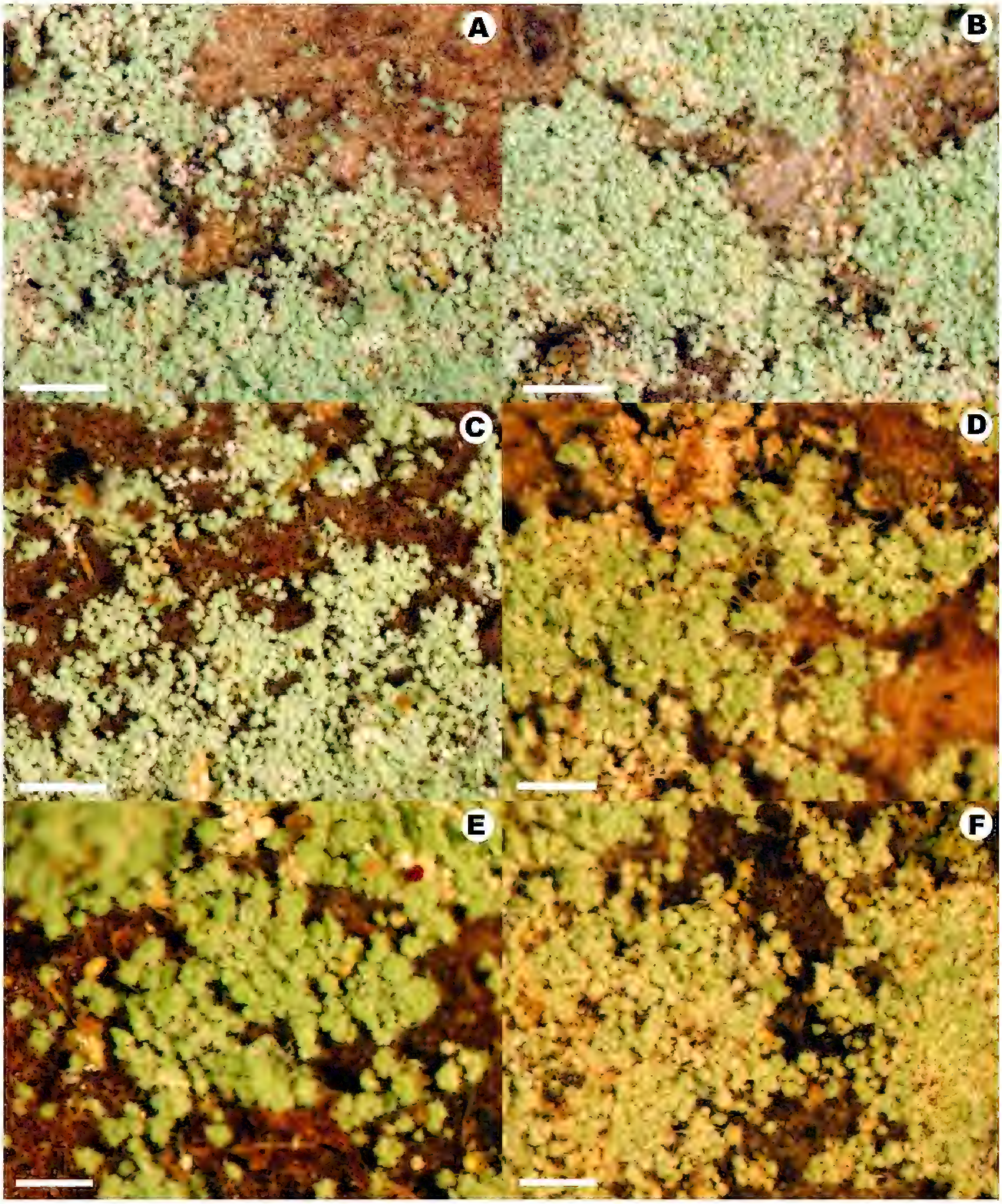

Figure 25, *Lepraria hodkinsoniana* (A, B, D and F are from *Lendemer 24535*; C and E are from *Lendemer 28250*). A–C, gross morphology of the thallus (scales = 0.5 mm). D–F. Detail of the granules (scales = 0.25 mm).

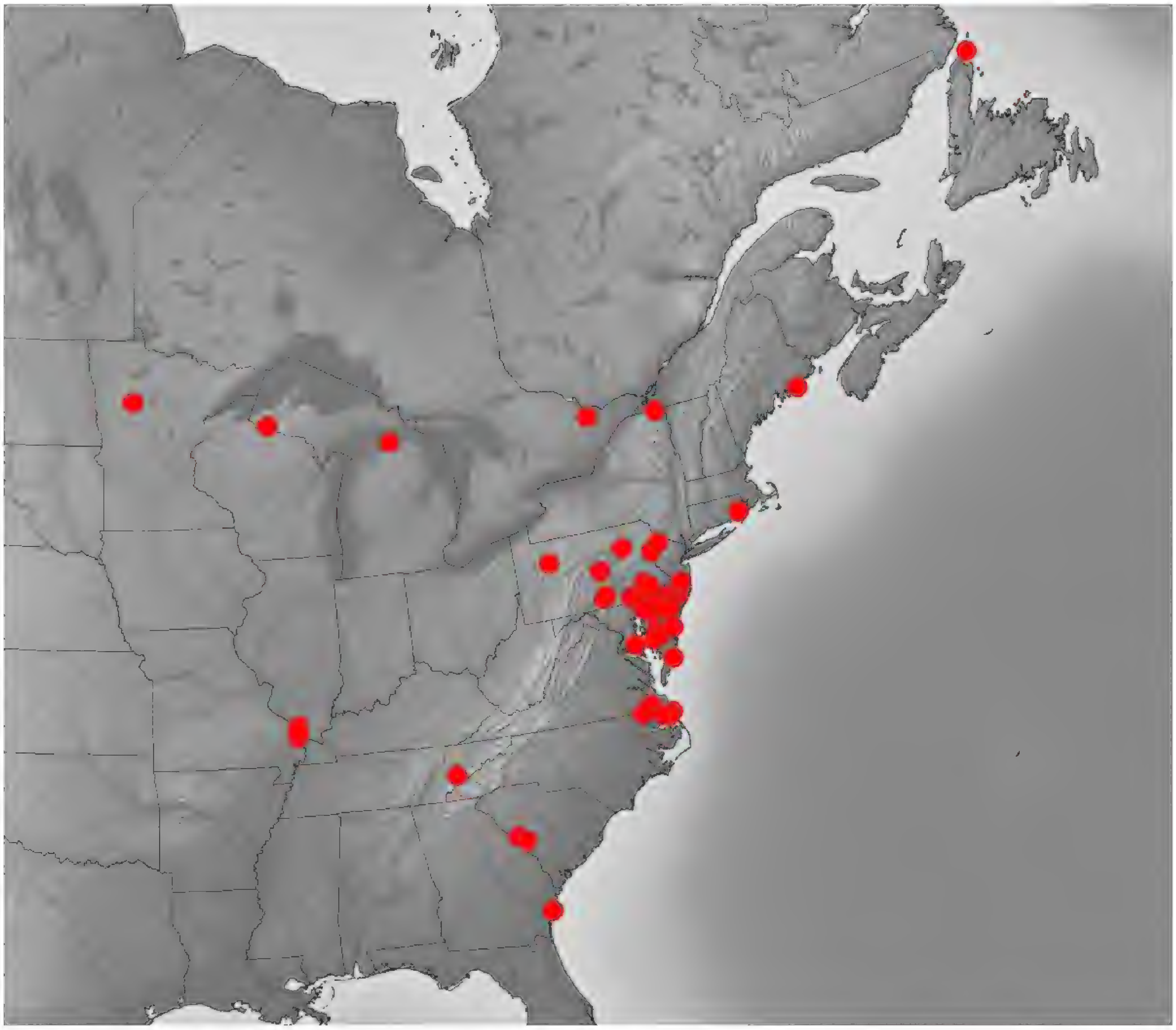

Figure 26, geographic distribution of *Lepraria hodkinsoniana* based on the specimens examined for this study.

Conservation status. – Although this species is infrequent throughout its geographic range, it nonetheless does not appear to have any imminent threats.

Discussion. – *Lepraria hodkinsoniana* is morphologically and chemically identical to *L. incana*, another corticolous species with divaricatic acid and zeorin that is ubiquitous in central and northern Europe. In phylogenetic analyses conducted by Lendemer (2011c) sequences derived from eastern North American populations of *L. incana* were recovered in a strongly supported clade sister to that comprised of sequences from European populations of *L. incana*. These monophyletic groups were strongly correlated with biogeography and as divergent as other species of lichen-forming fungi. Thus two geographically defined semi-cryptic species were recognized and the North American populations formally described as *L. hodkinsoniana*.

This species is easily recognized because it is the only member of the genus in eastern North America with an aggregate thallus that produces divaricatic acid. *Lepraria cryophila* is chemically similar in that it also produces divaricatic acid, however, it additionally produces high concentrations of nordivaricatic acid and lacks zeorin. That species also occurs primarily on rocks and has a thick placodioid thallus.

Selected additional specimens examined (56 total seen from North America; specimens with atranorin are indicated with at+). – **CANADA. ONTARIO.** LANARK CO.: N of Peneshula Rd. 0.6 mi W of int. w/ Cedar Cove Rd., 21.v.2011, on *Picea*, *J.C. Lendemer 28250 & R.E. Lee* (NY, at+). **U.S.A. DELAWARE.** SUSSEX CO.: 3-4 mi SW of Blades, 21.iv.1962, on *Pinus*, *C.F. Reed 55332* (NY). **GEORGIA.** McINTOSH CO.: Sapelo Island, Sapelo Island Wildlife Management Area, Dixie Highway between West Perimeter Rd., 15.xii.2009, on *Quercus*, *J.C. Lendemer 20608* (NY). **ILLINOIS.** ALEXANDER CO.: Shawnee National Forest, Grapevine Trail Picnic and Camping Area, 6.xi.2004, on bark, *R.C. Harris 50531* (NY, at+). JACKSON CO.: Shawnee National Forest, along W side of Cedar Lake, 6.xi.2004, on *Sassafras*, *R.C. Harris 50446* (NY). UNION CO.: Shawnee National Forest, N side of Hamburg Hill, 6.xi.2004, on *Liriodendron*, *R.C. Harris 50464* (NY). **MAINE.** WASHINGTON CO.: Town of Steuben, Dyer Neck, Eagle Hill, 26.vii.2006, on *Betula*, *R.C. Harris 52984* (NY, at+). **MARYLAND.** CALVERT CO.: Battle Creek Cypress Swamp, 4.vi.1977, on *Taxodium*, *E.G. Worthley s.n.* (NY). CAROLINE CO.: Idylwild State Wildlife Management Area, ~1 mi SW of Smithville, 18.iv.2006, on *Acer*, *J.C. Lendemer 6203 & W. Knapp* (NY). CECIL CO.: Elk Neck State Forest, Black Hill Tract, 30.xi.2009, on *Quercus*, *J.C. Lendemer 19963* (NY, at+). KENT CO.: Millington State Wildlife Management Area, along McKays Corner Rd. (Maryland Line Rd.), 18.iv.2006, on *Acer*, *J.C. Lendemer 6184 & W. Knapp* (NY). **MICHIGAN.** CHEBOYGAN CO.: Reese's Bog, W of Roberts Rd., 13.vii.2002, on bark, *W.R. Buck 41995* (NY, at+). GOGEBIC CO.: Ottawa National Forest, Bobcat Lake, 2 mi SW of Marenisco, 3.viii.2003, on *Tsuga*, *C.M. Wetmore 89388* (NY). **MINNESOTA.** HUBBARD CO.: Itasca State Park, just N of Twin Lakes along Lakes Drive, 8.viii.1975, on bark, *W.R. Buck B377* (NY). **NEW JERSEY.** CAMDEN CO.: Winslow Wildlife Management Area, ~3 mi S of jct 73/561[spur] and East Piney Hollow Rd., 4.ii.2009, on *Quercus*, *J.C. Lendemer 15361* (NY, at+). CUMBERLAND CO.: Peaslee Wildlife Management Area, ~2.4 mi S of jct NJ 49 and CR 646 (Cumberland Rd.), 2.ii.2009, on *Quercus*, *J.C. Lendemer 15170* (NY). GLOUCESTER CO.: Glassboro Wildlife Management Area, ~1.5 mi S of jct NJ 322 and CR 655 (Fries Mill Rd.), 4.ii.2009, on *Acer*, *J.C. Lendemer 15301* (NY, at+). OCEAN CO.: Manchester Wildlife Management Area, along N shore of Old Hurricane Brook 0–1 mi W of CR 359 (Hornerstown-Whiting Rd.), 5.ii.2009, on *Quercus*, *J.C. Lendemer 15373* (NY, at+). **NEW YORK.** BRONX CO.: New York Botanical Garden, 1.i.2001, on *Quercus*, *A. Amtoft 320* (NY). CLINTON CO.: Town of Mooers, trail to The Gulf Unique Area, 18.x.1996, on *Acer*, *R.C. Harris 39058* (NY). **PENNSYLVANIA.** CUMBERLAND CO.: Michaux State Forest, Big Pond Rd. 0.5 mi S of int. w/ Hogshead Rd., 2.vi.2009, on *Quercus*, *J.C. Lendemer 18304* (NY, at+). FOREST CO.: Cook Forest State Park, Jacks Hollow Rd. at jct w/ River Rd., 6.ix.2010, on *Acer*, *J.C. Lendemer 24535* (NY, at+). MONROE CO.: Tannersville Bog TNC Preserve, North Woods Trail, 26.vii.2009, on dead *Acer*, *J.C. Lendemer 18478* (NY). SULLIVAN CO.: Ricketts Glen State Park, S slopes above Big Run, 19.ix.2010, on rock, in overhang, *J.C. Lendemer 25670 & J. Kunsman* (NY). UNION CO.: Bald Eagle State Forest, Weikert Run Rd. 3 mi E of jct w/ Hoofnagle Rd., 15.ix.2010, on *Acer*, *J.C. Lendemer 25622* (NY). YORK CO.: York County Bridge No. 6, Mill Creek, W of confluence with Susquehanna River, 27.v.2009, on *Juglans*, *J.C. Lendemer 17937* (NY). **RHODE ISLAND.** WASHINGTON CO.: border of Towns of Exeter and South Kingstown, Marion Epply Wildlife Sanctuary, 16.ix.2006, on rotten tree, *R.C. Harris 53144* (NY). **SOUTH CAROLINA.** AIKEN CO.: The Hitchcock Woods, just SW of city of Aiken, along Tea Cottage Path from entrance on Dibble Rd., 14.iii.2010, on *Nyssa*, *J.C. Lendemer 22149* (NY). EDGEFIELD CO.: Sumter National Forest, along FSR 634, 1.3 mi W of SC 52, 17.iii.1997, on *Betula*, *R.C. Harris 40249* (NY). **TENNESSEE.** BLOUNT CO.: Great Smoky Mountains National Park, Foothills Parkway tract, bluffs above the NW shore of the Little River, 22.vi.2011, on *Tsuga*, *J.C. Lendemer et al. 29476* (NY). **VIRGINIA.** SUFFOLK CITY: Dismal Swamp National Wildlife Refuge, vicinity of canal bridge over Jericho Ditch, 12.xii.2009, on *Ilex*, *J.C. Lendemer 20482 & B.P. Hodkinson* (NY).

11) *Lepraria humida* Slav.-Bayr. & Orange, Lichenologist 38: 505. 2006. TYPE: **WALES:** Merioneth (V.C. 48), Rhyd-y-sarn, south of Clogwyn y Geifr, grid ref. 23/684.421, 90 m, *Quercus petraea* woodland, 25.1.2005, on shaded, rain-sheltered siliceous rock face, *A. Orange 15754* (PRA [n.v.], holotype; BG, NMW, isotypes [both n.v.]).

FIGURES 27 AND 28.

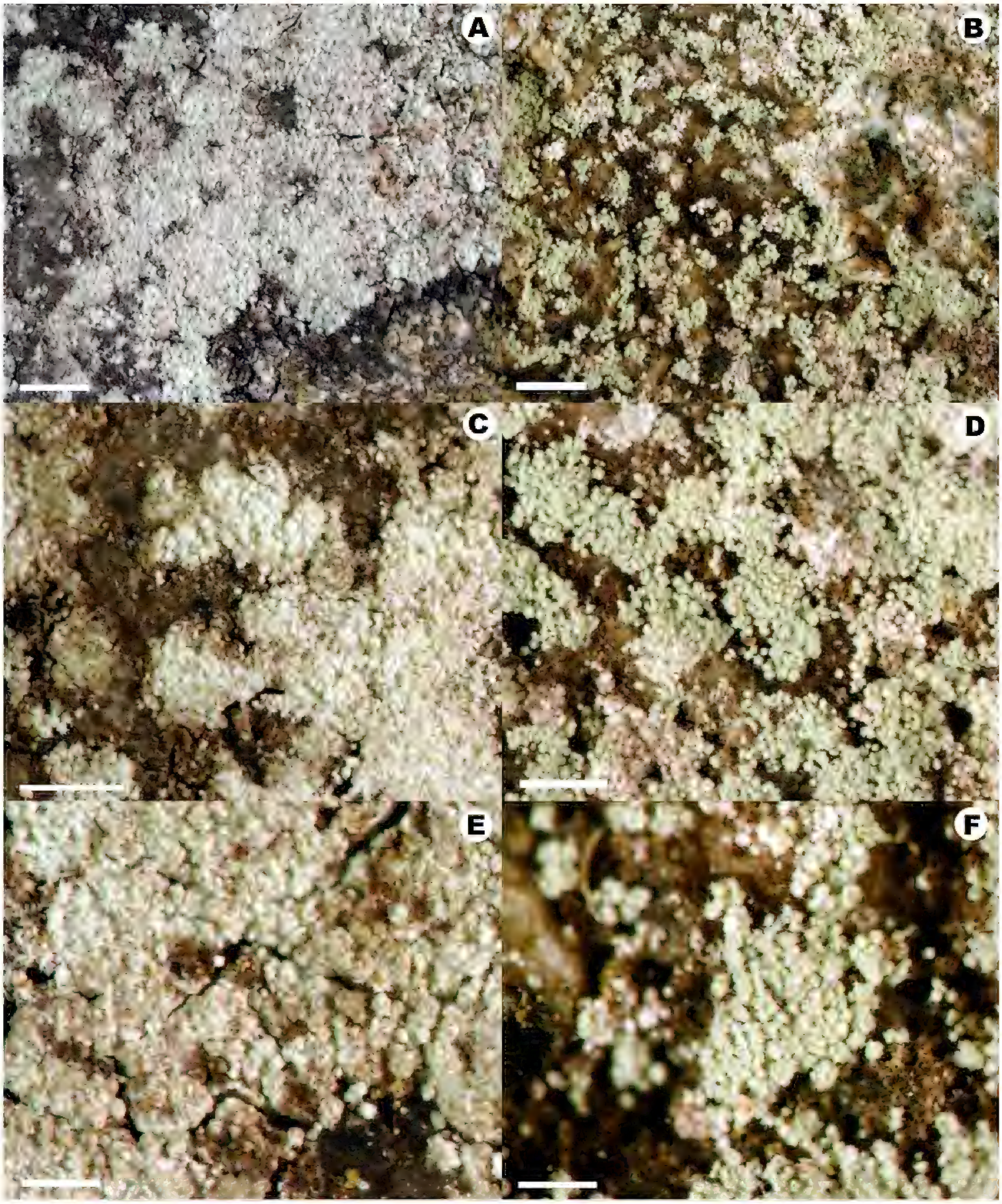

Figure 27, *Lepraria humida* (*Lendemer 12651* is left; *Lendemer 22865* is right). A–B, gross morphology of the thallus, note the tendency to form dispersed aggregations (scales = 1.0 mm). C–D, detail of the thallus (scales = 0.5 mm). E–F, detail of the granules (scales = 0.25 mm).

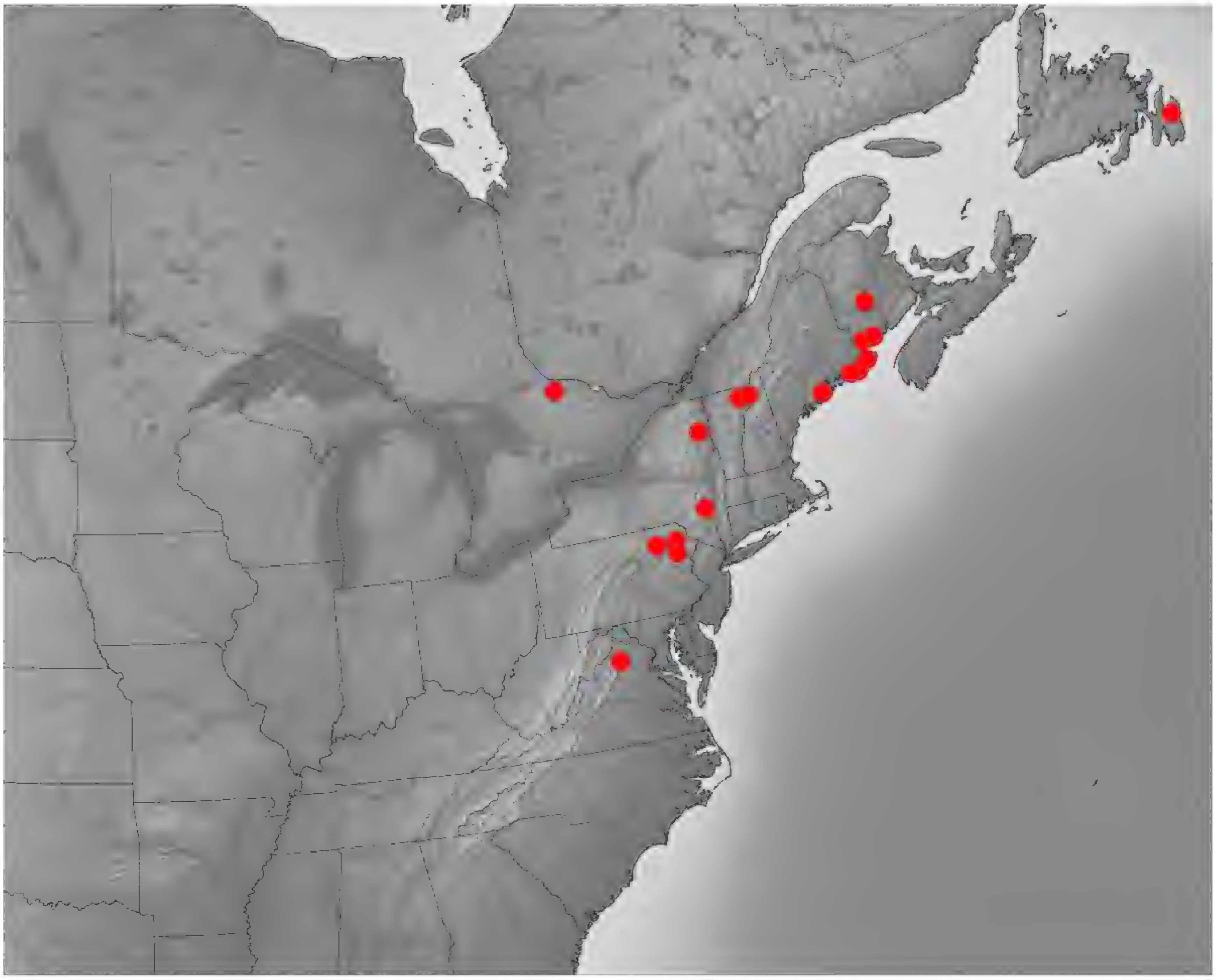

Figure 28, geographic distribution of *Lepraria humida* based on the specimens examined for this study.

Description. – **Thallus** crustose, leprose, aggregated, discontinuous and not stratified, initially composed of isolated granules that divide to form aggregations, the aggregations often remaining distinct and separated, sometimes merging to form a thin crust (<0.2 mm thick), white-gray in color; **hyphae** hyaline, [1.4]–(1.9)–2.6–(3.3)–[3.7] µm (*n*=43) in width, septate, secund, obscured by a thick layer of POL+ crystals that dissolve in KOH; **prothallus** persistent; **hypothallus** absent; **rhizohyphae** absent; **granules** globose, [18]–(27)–36–(46)–[72] µm (*n*=93) in diameter, ecorticate, well organized and discrete, remaining distinct and not forming compound units; **photobiont** green, coccoid, cells globose, [5.7]–(6.9)–8.8–(10.7)–[13.8] µm (*n*=103) in width.

Chemistry. – Atranorin, rangiformic/jackinic acid, norrangiformic/norjackinic acid (occasionally in low concentrations). Spot tests: K+ yellow, C-, KC-, P+ weak yellow, UV-.

It should be noted that neither stictic acid nor anthraquinones were detected in any of the specimens of *Lepraria humida* reviewed for this study. Stictic acid was interpreted as a contaminent in *L. humida* Slavíková-Bayerová and Orange (2006). While the presence of anthraquinones was considered among the most distignishing features of *L. humida*, Slavíková-Bayerová and Orange (2006) noted that the substances were often sparsely produced in the thallus and difficult to detect.

Ecology and distribution. – *Lepraria humida* is not uncommon in the central and northern Appalachian Mountains of eastern North America (figure 28). Interestingly, it is not known to occur outside of this region in North America, however this may be due to collector bias that often negatively impacts sterile crustose lichens (Lendemer 2011b). All the populations encountered to date were found on non-calcareous rocks in shaded rock overhangs or sheltered vertical rock faces.

Conservation status. – The North American populations of *Lepraria humida* may warrant conservation consideration because they all occur in protected rock overhangs, a habitat easily impacted by changes in small scale moisture regimes (Lendemer et al. 2009). As is the case for *L. cryophila*, this species may be useful as an indicator of the presence of rarer lichens that are less conspicuous.

Discussion. – Somewhat surprisingly *Lepraria humida* is a very distinctive species that is only likely to be confused with *L. caesiella* or *L. jackii* in the field. *Lepraria caesiella* differs in producing zeorin and pallidic acid rather than jackinic acid and norjackinic acid. It also has a more temperate distribution and wider ecological amplitude (Lendemer 2012a). *Lepraria jackii* is morphologically identical to *L. humida*, essentially differing only in the production of roccellic/angardianic acid in addition to jackinic acid and norjackinic acid. Populations of *L. neglecta* that produce only atranorin and fatty acids could be confused with *L. humida*. However in that species the granules have a distinct compact appearance due to the production of a thick pseudocortex. *Lepraria rigidula* could also be confused with *L. humida*. However that species produces nephrosteranic acid rather than jackinic acid and norjackinic acid and also has a thicker placodioid thallus and granules that produce conspicuous projecting hyphae that persist into maturity (Lendemer 2011a). This is the first report of *L. humida* for North America.

Selected specimens examined (17 total seen from North America). – **CANADA. NEW BRUNSWICK.** CHARLOTTE CO.: Caughey-Taylor Nature Preserve, 2.v.2011, on rock in overhang, *J.C. Lendemer 28090-A* (NY). **NEWFOUNDLAND AND LABRADOR.** NEWFOUNDLAND: Island of Newfoundland, Avalon Peninsula, Butterpot Provincial Park, E side of Big Otter Pond, 9.ix.2007, on rock, in overhang, *J.C. Lendemer 10157* (NY). **ONTARIO.** NIPISSING DIST.: Algonquin Provincial Park, E shore of Carl Wilson Lake, 31.vii.2011, on rock, in overhang, *I.M. Brodo et al. 33067* (NY). **U.S.A. MAINE.** KNOX CO.: Camden Hills State Park, 29.v.2009, on rock in overhang, *R.C. Harris 55530* (NY). **NEW YORK.** ESSEX CO.: Chapel Pond, 19.ix.2004, on rock, *J.C. Lendemer et al. 3133* (NY). GREENE CO.: Town of Hunter, Stony Clove Notch, 13.ix.2008, on rock in overhang, *J.C. Lendemer 14107* (NY). **PENNSYLVANIA.** LACKAWANNA CO.: State Game Lands No. 300, N end of Moosic Mountain, 3.vii.2008, on rock in overhang, *J.C. Lendemer 12457* (NY). **VERMONT.** ESSEX CO.: Town of Brunswick, West Mountain Wildlife Management Area, 18.v.2008, on boulder, *R.C. Harris 54517* (NY). ORLEANS CO.: Willoughby State Forest, 18.x.2010, on rock in overhang, *J.C. Lendemer 27118 & M. Sundue* (NY). **VIRGINIA.** WARREN CO.: Shenandoah National Park, North Marshall, 13.iii.2005, on rock face, *J.C. Lendemer 4413* (NY).

12) *Lepraria jackii* Tønsberg, Sommerfeltia 14: 200. 1992. TYPE: **NORWAY. NORD-TRØNDELAG.** Grong, W of Abrahammyra, 80–100 m, 16.ix.1981, on *Picea abies*, *T. Tønsberg 6176* (BG!, holotype).

FIGURES 29 AND 30.

Description. – **Thallus** crustose, leprose, aggregated, discontinuous and not stratified, initially composed of isolated granules that divide to form aggregations, eventually merging to form a thin crust (<0.1 mm thick), greenish-gray in color; **hyphae** hyaline, [1.4]–(2.3)–2.9–(3.4)–[4.2] µm (*n*=96) in width, septate, secund, obscured by a thick layer of POL+ crystals that dissolve in KOH; **prothallus** persistent; **hypothallus** absent; **rhizohyphae** absent; **granules** globose, [14]–(23)–30–(38)–[54] µm (*n*=125) in diameter, ecorticate, well organized and discrete, remaining distinct and not forming compound units; **photobiont** green, coccoid, cells globose, [4.8]–(6.7)–8.9–(11.1)–[14.4] µm (*n*=101) in width.

Chemistry. – Chemotype 1 (not present in North America; corresponds to the holotype): atranorin, roccellic/angardianic acid, jackinic/rangiformic acid, stictic acid; spot tests: K+ yellow, KC-, C-, P+ orange, UV-. Chemotype 2 (present in North America): atranorin, roccellic/angardianic acid, jackinic/rangiformic acid; spot tests: K+ yellow, KC-, C-, P+ weak yellow, UV-.

Ecology and distribution. – In North America *Lepraria jackii* occurs in the Canadian Maritimes and Pacific Nothwest, extending southward in the Appalachian Mountains in the eastern portion of the continent (figure 30). The species typically occurs on the bases of conifers, especially spruce (*Picea*), and more rarely on sheltered rocks or humus.

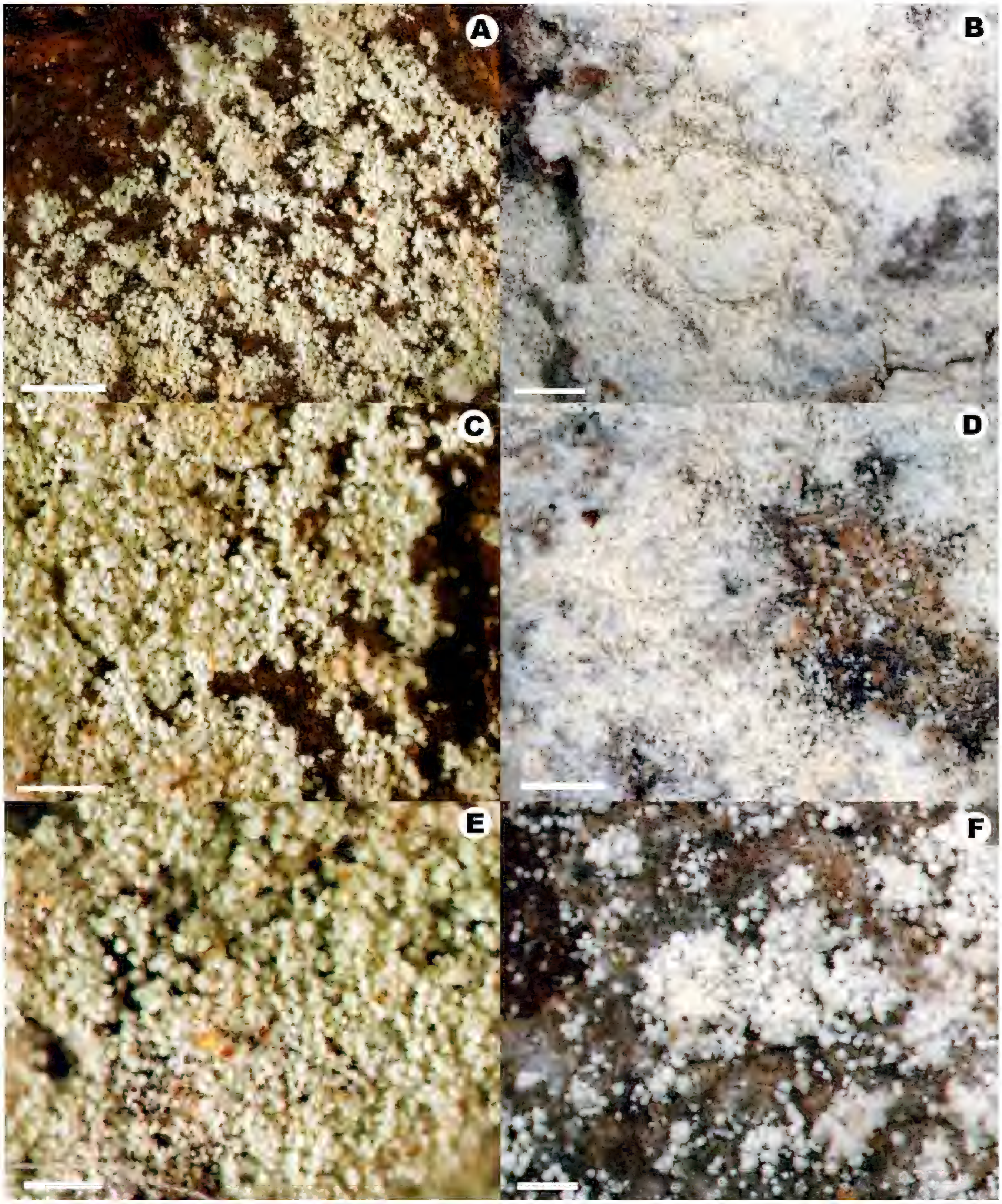

Figure 29, comparison of holotype of *Lepraria jackii* (*Tønsberg 6176*, right) to a North American population (*LaGreca 1980*, left). A–B, gross morphology of the thallus (scales = 0.5 mm and 1.0 respectively). C–D, detail of the thallus (scales = 0.5 mm). E–F, detail of the granules (scales = 0.25 mm).

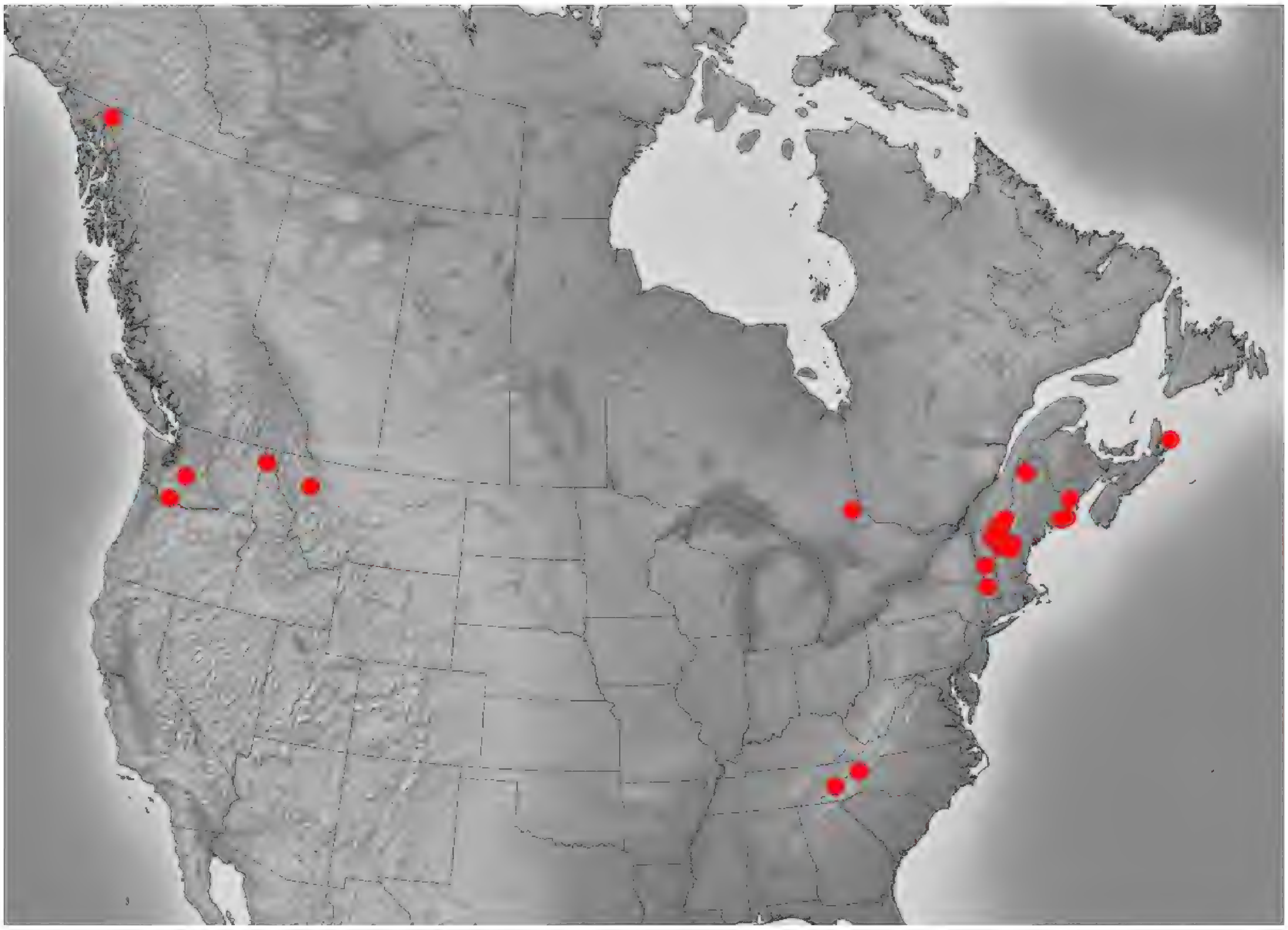

Figure 30, geographic distribution of *Lepraria jackii* based on the specimens examined for this study.

Conservation status. – *Lepraria jackii* is infrequent in North America. However, this may be an artifact of collector bias. The taxon should be classified as "data deficient" pending further study of its northern distribution. The populations in the central and southern Appalachians may warrant conservation consideration because they are restricted to the threatened spruce-fir forests (Lendemer et al. 2013).

Discussion. – *Lepraria jackii* is actually a very distinct taxon on account of its aggregate thallus, granules that lack projecting hyphae at maturity, and production of roccellic/angardianic acid and rangiformic/jackinic acid, in addition to atranorin. Corticolous populations are unlikely to be confused with any other species, except for the fatty acid producing chemotypes of *L. neglecta* That taxon typically occurs in exposed habitats (whereas *L. jackii* occurs in protected habitats) and the granules appear compact due to the presence of a well-developed pseudocortex. Saxicolous populations can be confused with *L. humida* and TLC is required to elucidate the presence of roccellic/angardianic acid in *L. jackii* (that substance is absent in *L. humida*).

Selected specimens examined (16 total seen from North America). – **CANADA. NEW BRUNSWICK.** CHARLOTTE CO.: Caughey-Taylor Nature Preserve, 2.v.2011, on *Picea* base, *J.C. Lendemer 28050* (NY). **NOVA SCOTIA.** INVERNESS CO.: Cape Breton Island, Trout Brook Wilderness Area, 27.vii.2000, on *Acer*, *S. Selva et al. 8854A* (UMFK). **ONTARIO.** NIPISSING DIST.: Lake Temagami area, Kokoko Bay, cove N of Birch Lake, 14.vii.2009, on *Pinus*, *I.M. Brodo 32442 & F. Brodo* (CANL). **U.S.A. IDAHO.** BONNER CO.: Priest River Experimetnal Forest, 7.vii.1969, on *Thuja*, *T.L. Esslinger 1030* (COLO). **MAINE.** AROOSTOOK CO.: T13 R10 WELS, SW section of township, 8.vi.1987, on *Larix*, *S. Selva et al. 2892A-A* (UMFK). WASHINGTON CO.: Town of Beals, Great Wass Island, 7.vi.2010, on *Picea* base, *J.C. Lendemer 22610* (NY). **MASSACHUSETTS.** BERKSHIRE CO.: Town of Williamstown, Mt. Greylock State Reservation, 6.v.1995, on bark, *R.C. Harris 36493* (NY). **MONTANA.** LAKE CO.: 0.5 km S of Soup Creek Campground, 28.viii.1977, on conifer bark, *B. McCune*

4748 (NY). **NORTH CAROLINA.** MITCHELL CO.: Pisgah National Forest, trail to Roan High Bluff, 25.ix.1993, on *Abies*, *R.C. Harris 30927* (NY). **NEW HAMPSHIRE.** CARROLL CO.: Hemenway State Forest, Big Pines Special Use Permit Area, 23.vi.1994, on *Pinus*, *S. Selva 5935 & P. Edberg* (UMFK). COOS CO.: Town of Stewartstown, Hurlbert Swamp Preserve, 17.v.2008, on *Abies*, *R.C. Harris 54424* (NY). GRAFTON CO.: White Mountains National Forest, Owls Head Candidate Research Natural Area, 3.vi.1993, on *Pinus*, *S. Selva 5545A & P. Edberg* (UMFK). **TENNESSEE.** SEVIER CO.: Great Smoky Mountains National Park, Chimney Tops Trail, 28.vi.2010, on soil at base of *Betula lenta*, *J.C. Lendemer et al. 23345* (NY). **VERMONT.** CALEDONIA CO.: Town of Wheelock, Wheelock Farm, 22.x.2010, on stump, *J.C. Lendemer 27518 & M. Sundue* (NY). ESSEX CO.: Town of Averill, Quimby Country resort property, 19.v.2008, on rotten wood, *R.C. Harris 54606* (NY). **WASHINGTON.** PIERCE CO.: Mount Bake-Snoqualmie National Forest, White River Ranger Distr., Crystal Mountain Ski Resort, 4.viii.1996, on bark, *W.R. Buck 30373* (NY). SKAMANIA CO.: Gifford Pinchot National Forest, near Lost Lake, W of Government Mineral Springs, 22.vi.1962, on bark, *A. Pechanec 1004* (COLO).

13) *Lepraria lanata* Tønsberg, Opuscula Philolichenum 4: 51. 2007. TYPE: **U.S.A. TENNESSEE.** SEVIER CO.: Great Smoky Mountains National Park, along the Boulevard Trail, 1870 m, on shaded, overhanging, schistose rock wall, 8.ix.2005, *T. Tønsberg 36347* (BG [n.v.], holotype; NY!, isotype).

FIGURES 31 AND 32.

Description. – **Thallus** crustose, leprose, aggregated, discontinuous and not stratified, initially composed of isolated granules that divide to form aggregations, eventually merging to form a thick crust (<0.1–1.0 mm thick), gray-blue in color; **hyphae** hyaline or darkly pigmented, [2.6]–(3.7)–5.7–(7.4)–[9.6] µm (*n*=32) in width, septate, secund, obscured by a thick layer of POL+ crystals that dissolve in KOH; **prothallus** persistent, extending outward from the granules, eventually causing them to become entangled a loose network of hyphae and form large spherical masses; **hypothallus** absent; **rhizohyphae** absent; **granules** globose, [28]–(40)–57–(74)–[102] µm (*n*=32) in diameter, ecorticate, well organized and discrete, immediately forming large compound units surrounded and entwined in prothalline hyphae; **photobiont** green, coccoid, cells globose, [6]–(7.4)–8.6–(9.8)–[11] µm (*n*=32) in width.

Chemistry. – Roccellic/angardianic acid, protocetraric acid. Spot tests: K-, C-, KC-, P+ orange-red, UV-.

Ecology and distribution. – *Lepraria lanata* is a rare species that is restricted to the higher elevations (>4,000 ft. or 1200 m.) of the southern Appalachian Mountains in eastern North America (figure 32). It occurs on soil, humus, and other organic matter in sheltered habitats, such as shaded rock faces and overhangs. All but one population (whose substrate is unknown) were found associated with rocks of the Anakeesta Formation in Great Smoky Mountains National Park. While it is unlikely that this relationship is obligatory, it may indicate *L. lanata* shows a preference for a chemically similar rock types.

Conservation status. – This species should be considered a conservation priority. All the known populations are from high elevations in the southern Appalachian Mountains, specifically in Great Smoky Mountains National Park. (Note: a single historical record is known from Grandfather Mountain in Avery Co., NC.) Although the species occurs within a federally protected biological reserve, it occurs in habitats that are under considerable threats from acid fog and climate change. How these forces will impact *Lepraria lanata*, and numerous other species, remains unknown. Many of the populations of this species are also small, and do not form the large colonies typical of most other *Lepraria* species. Additional study is needed to determine whether *L. lanata* occurs at high elevation localities elsewhere in the southern Appalachians. While one typically could attribute the absence of such collections to collector bias, this is not likely the case for *L. lanata*.

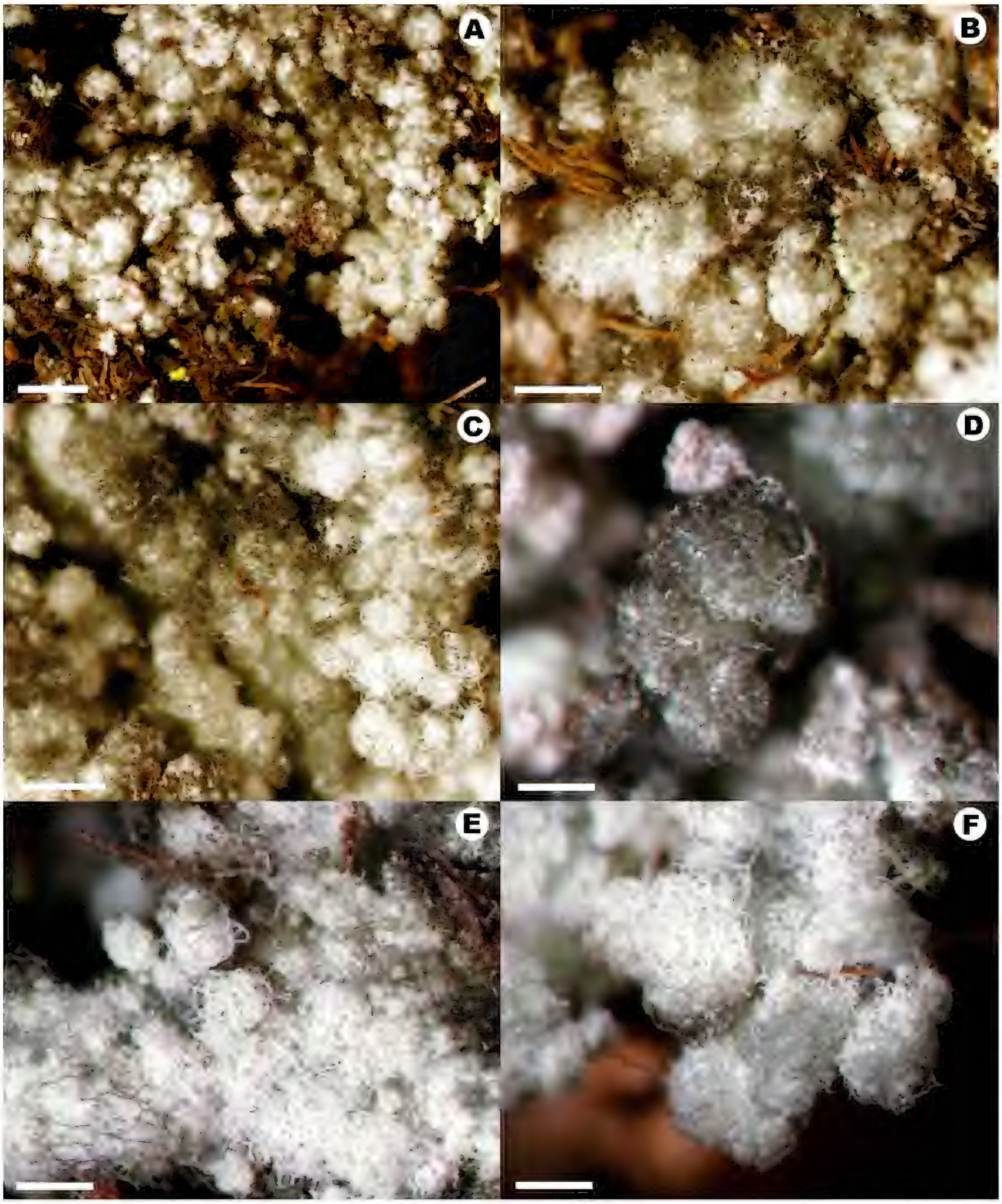

Figure 31, *Lepraria lanata* (all from *Lendemer 23306*). A, gross morphology of the thallus (scale = 1.0 mm). B–C, detail of the thallus (scales = 0.5 mm). D–F, detail of the granules, note the tendency for some hyphae to become darkly pigmented (scales = 0.25 mm).

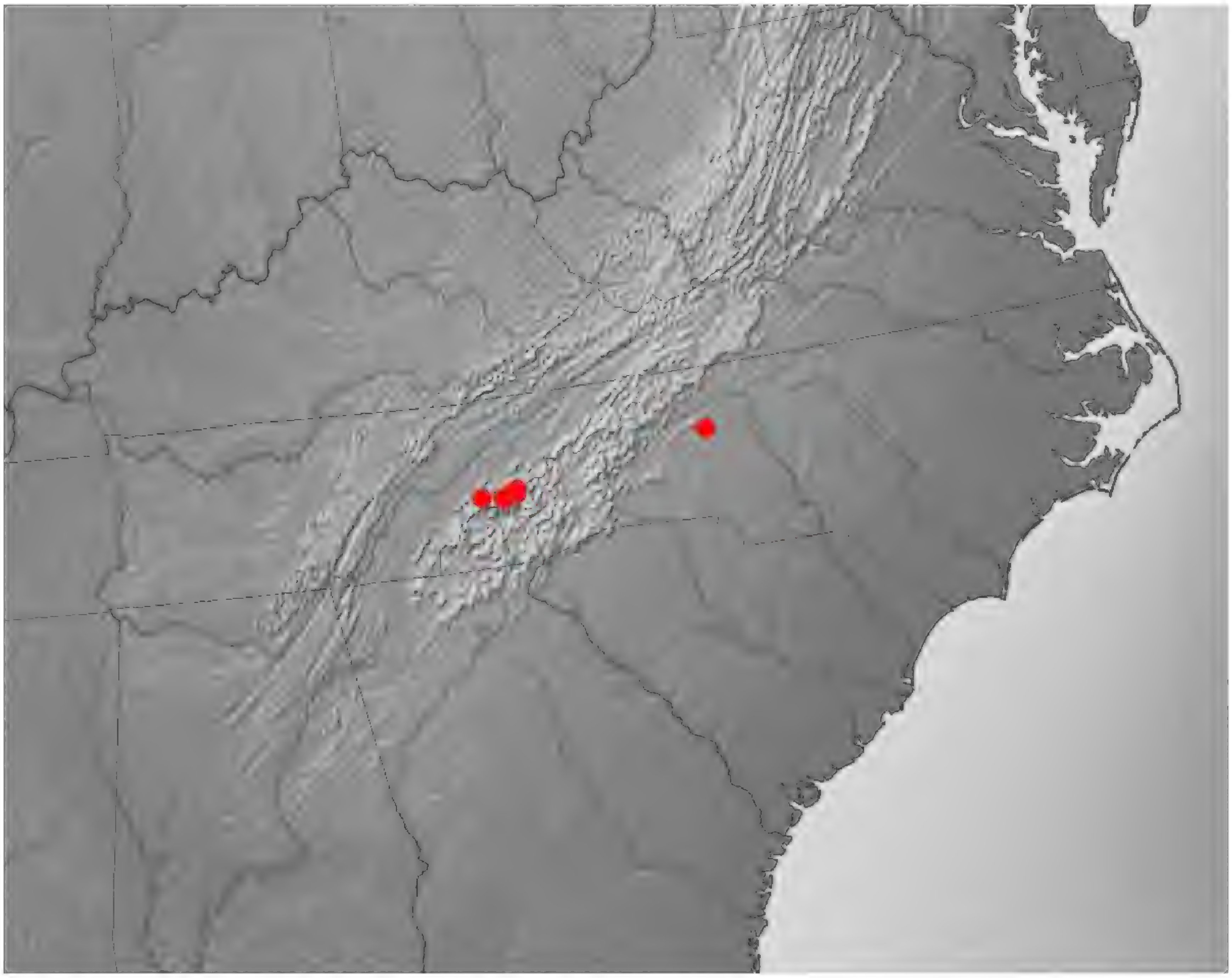

Figure 32, geographic distribution of *Lepraria lanata* based on the specimens examined for this study.

Discussion. – *Lepraria lanata* is an extremely distinctive species that can easily be identified with the naked eye in the field. The morphology of the thallus of *L. lanata* appears to be unique within the genus and does not fit well within any of the types defined by Lendemer (2011a). Thus, a new type, the *lanata*-type is proposed here. Following the morphological scheme of Lendemer (2011a) the *lanata*-type thallus is a unique type of aggregate thallus in which the granules become connected by the persistent prothalline hyphae to form massive spherical aggregations that resemble large granules (> 0.1 mm). Although based on a limited sampling, the granules in *L. lanata* appear to be larger than any other species of *Lepraria* studied to date. This is also the case for the prothalline hyphae (see figure 30).

The aggregations of granules in *Lepraria lanata*, which are larger than 0.1 mm in diameter, are among the largest known in the genus. The size of these structures, which resemble fuzzy cotton balls, coupled with the production of protocetraric acid and roccellic/angardianic acid are diagnostic. No other species of *Lepraria* could possibly be confused with *L. lanata*.

Selected specimens examined (8 total seen from North America). – **U.S.A. NORTH CAROLINA.** SWAIN CO.: Great Smoky Mountains National Park, Appalachian Trail between Laurel Top and Pecks Corner, 3.vi.2011, on siliceous rock, *J. Hollinger 2962* (NY). **TENNESSEE.** SEVIER CO.: Great Smoky Mountains National Park, Ramsey Cascades, 6.v.1973, on shaded bluff face, *P.R. Fantz s.n.* (NY); Great Smoky Mountains National Park, Mt. LeConte near Alum Cave, 29.xi.2009, on steep rock face, *J. Hollinger 20091129.12* (NY); Great Smoky Mountains National Park, summit of the Chimney Tops, 28.vi.2010, on humus in overhang, *J.C. Lendemer et al. 23306* (NY); Great Smoky Mountains National Park, Boulevard Trail, 2.vi.2011, on siliceous rock, *J. Hollinger 2975* (NY).

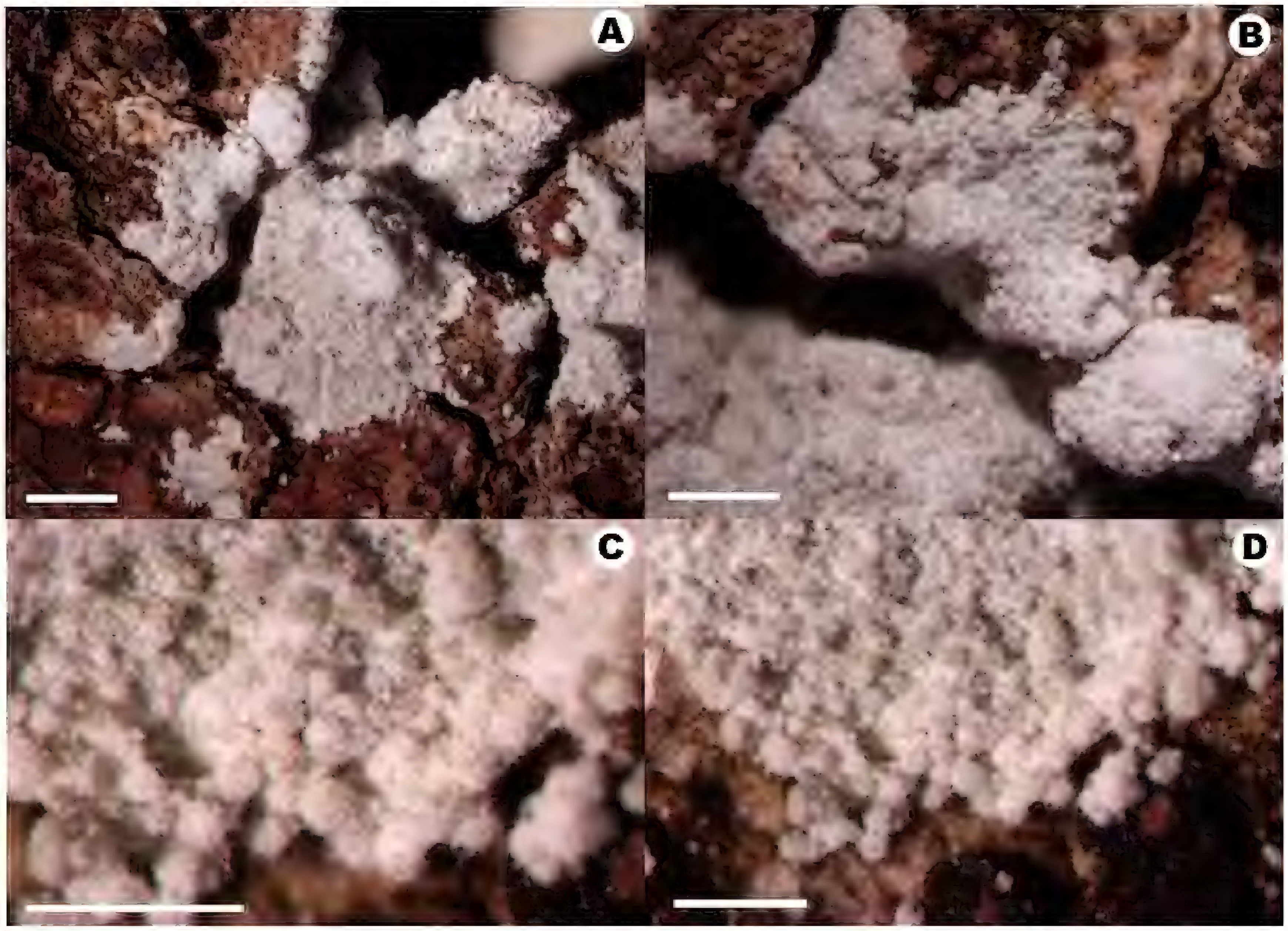

Figure 33, *Lepraria lecanorica* (all from the holotype). A–B, macromorphology of the thallus (scales = 2.0 mm and 1.0 mm respectively). C, detail of the granules (scale = 0.5 mm). D, detail of the thallus margin (scale = 0.5 mm).

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14) ***Lepraria lecanorica*** **Tønsberg,** Lichen Flora of the Greater Sonoran Desert Region 2: 326. 2004. TYPE: **U.S.A. ARIZONA.** COCONINO CO.: Coconino National Forest, SSW of Flagstaff, uphill from Hwy 89, 1675–1710 m, dry W-facing slope with *Pseudotsuga menziesii* and *Pinus*, 18.iv.2001, corticolous on shaded base of trunk of *Quercus*, *T. Tønsberg 28991* (BG!, holotype).

FIGURES 33–35.

Description. – **Thallus** crustose, leprose, aggregated, discontinuous and not stratified, initially composed of isolated granules that divide to form aggregations, eventually merging to form a thin crust (0.05–0.2 mm thick), blue-white in color; **hyphae** hyaline, [1.5]–(2.1)–2.6–(3.1)–[3.6] µm (*n*=32) in width, septate, secund, obscured by a thick layer of POL+ crystals that not dissolve in KOH; **prothallus** persistent; **hypothallus** absent; **rhizohyphae** absent; **granules** globose, [42]–(51)–81–(111)–[156] µm (*n*=32) in diameter, ecorticate, developing a pseudocortex with age, well organized and discrete, remaining distinct and not forming compound units; **photobiont** green, coccoid, cells globose, [6]–(7.3)–10–(12.7)–[15.9] µm (*n*=32) in width.

Chemistry. – Atranorin, lecanoric acid. Spot tests: K+ yellowish, C+ pink/red, KC+ pink/red, P-, UV-.

Ecology and distribution. – This species was originally described from mountainous regions of the Sonoran Desert in northern Arizona (Tønsberg 2004) and subsequently reported from South America by Flakus and Kukwa (2007). Only a handful of North American populations have been discovered (figure 35). However, this is almost certainly due to the limited collection efforts focused on sterile crustose lichens

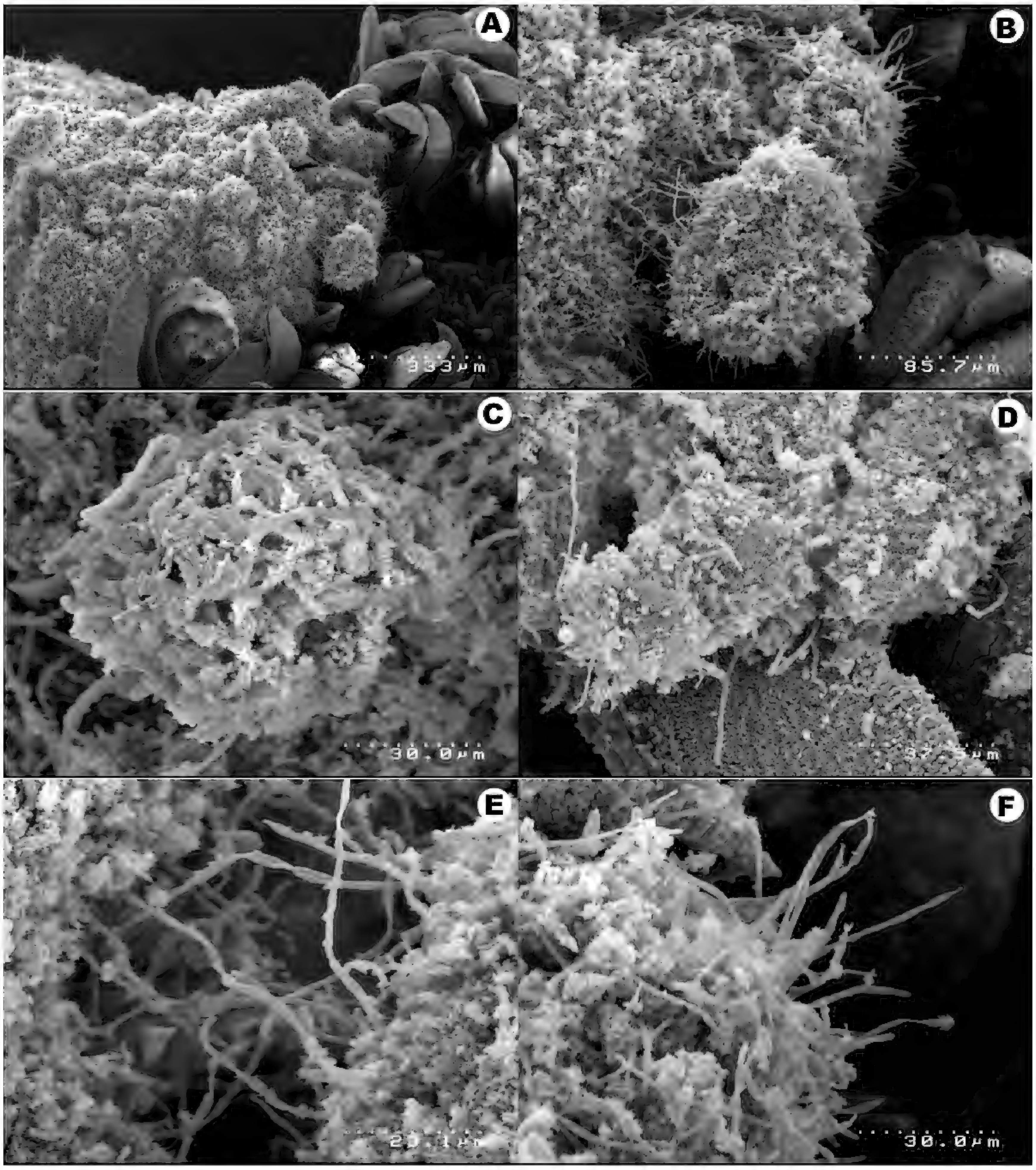

Figure 34, SEMs of *Lepraria lecanorica* (all from the holotype, scales as indicated). A, macromorphology of the thallus. B, thallus edge with prothalline hyphae extending outward from the granules. C, young ecorticate granule. D, mature granules with pseudocortex. E–F, detail of prothalline hyphae extending outward from the granules.

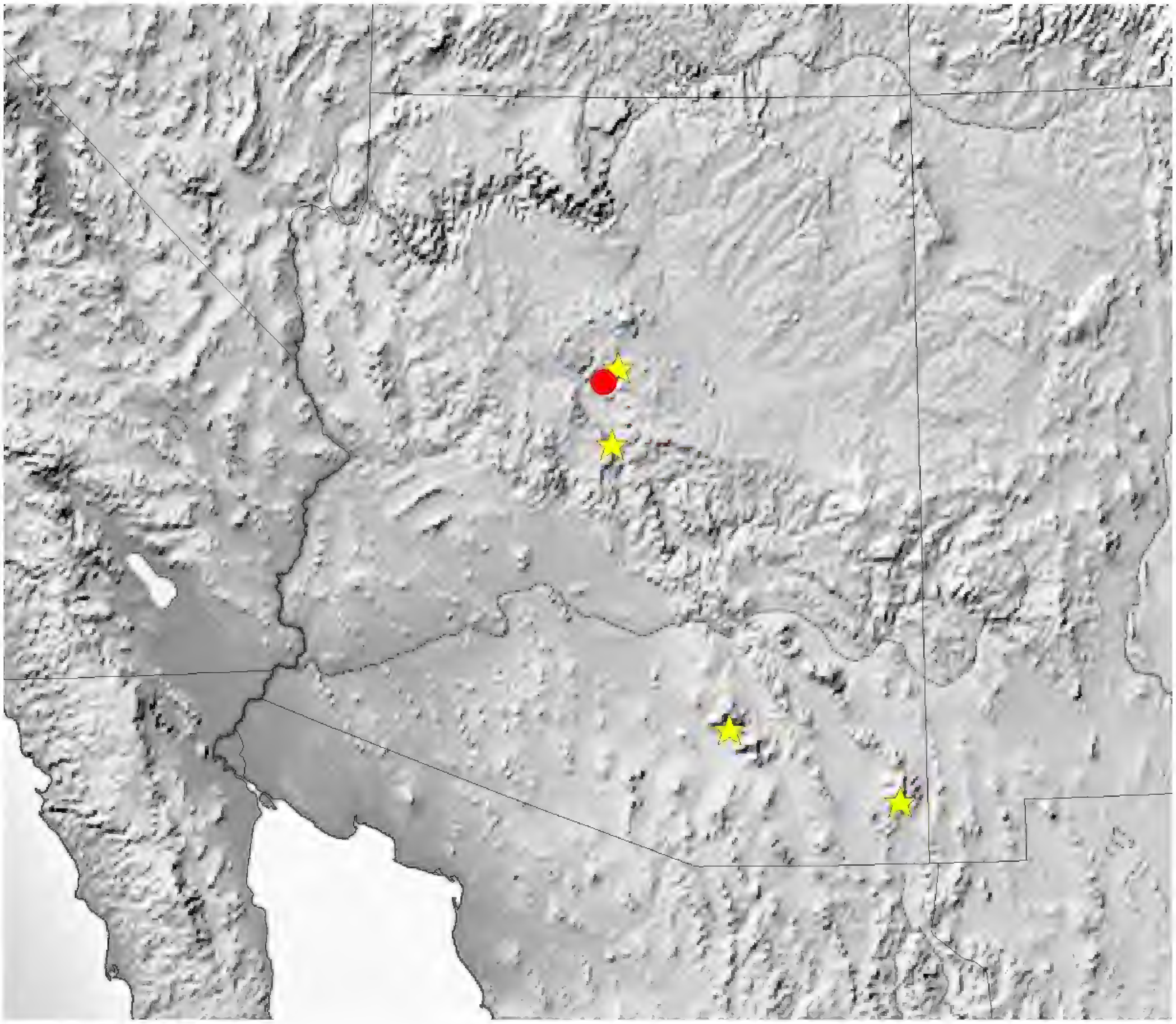

Figure 35, geographic distribution of *Lepraria lecanorica* (red dot = specimens examined for this study; yellow stars = vouchers from CNALH and protologue not seen for this study).

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in the greater Sonoran Desert region. Although not explicitly stated in the protologue, the type collection was found growing on a tree in a humid ravine. An effort was made to locate additional material during a collecting trip in 2010. This search yielded a single population that was found growing on humus in a sheltered rock overhang where it was mixed with thalli of the fatty acid producing chemotype of *Lepraria neglecta*.

Conservation status. – *Lepraria lecanorica* is rare in North America. However, further study of its geographic distribution is needed before its status can be evaluated.

Discussion. – *Lepraria lecanorica* represents a chemically distinctive taxon with a *caesioalba*-type aggregate thallus (figures 33 and 34). Further study with molecular methods is needed to determine whether this taxon is distinct, or represents another chemical variant of *L. neglecta*, which is the only species likely to be confused with *L. lecanorica*.

Additional specimen examined (2 total seen from North America). – **U.S.A. ARIZONA.** YAVAPAI CO.: Coconino National Forest, W-facing slopes of Doe Mountain, 7.iii.2010, on soil, on cliff, *J.C. Lendemer 21817-A & A. Moroz* (NY).

15) ***Lepraria leprolomopsis* Diederich & Sérus. *in* Aptroot et al.,** Biblioth. Lichenol. 64: 76. 1997. TYPE: **PAPUA NEW GUINEA. SIMBU PROV.:** Mt. Wilhelm area, c. 16 km on new road under construction from Gembogl to Goroka, 2800 m, mossy mountain forest, 9.viii.1992, epiphyte, *H. Sipman 3591* (B [n.v.], holotype; LG [n.v.], hb. Diederich!, isotypes).

FIGURES 36, 38, AND 39.

Description – **Thallus** crustose, leprose, continuous and distinctly bi-layered, whitish-blue to bluish-green in color; **hyphae** anchoring the granules to each other, (3.0-)3.5–4.0 µm wide, hyaline, obscurely septate, frequently branching at the septa, thick-walled, obscured by a thick layer of crystals that dissolve in KOH; **prothallus** disappearing with age; **hypothallus** a well-developed layer of loosely intertwined hyphae surrounding and subtending the granules, projecting outward from the edge of the thallus, lowermost layers variably pigmented with an orange-brown pigment that intensifies in KOH and then turns purplish; **rhizohyphae** pale to orange-brown-pigmented depending on proximity to the thallus margin, extending from the hypothallus to anchor the thallus to the substrate; **granules** small, (25-)30–40(-45) µm in diameter, with a poorly developed pseudocortex of one to several layers of gelatinized hyphae, globose, well organized and discrete, with a core of 1 to ± 10 aggregated algal cells, regularly dividing and regularly forming compound units of many individual granules; **photobiont** green, coccoid, cells globose, 8–13 µm in diameter.

Chemistry - Atranorin, unidentified pigment (?), norstictic acid complex (trace), stictic acid complex (major). Spot tests: unpigmented portions, K+ yellowish, C-, KC-, P+ orange, UV-; pigmented portions, K+ dark red turning purplish, C-, KC-, P-, UV-.

Ecology and distribution. – This species is known from two localities in the Appalachian Mountains of eastern North America (figure 39). It was first discovered in a remarkable series of deep sandstone channels with many high humidity microhabitats in northwestern Alabama at the foothills of the Appalachian Mountains. It should be noted that the disjunct population of *Crocynia pyxinoides* Nyl. mapped in northwestern Alabama by Brodo et al. (2001) refers to this record. The second occurrence was found in the New River Gorge in eastern West Virginia. Although it would be easy to explain this unusual distribution as reflecting collector bias, the number of collections of the morphologically similar species *L. finkii* likely indicate that *L. leprolomopsis* is rare.

Conservation status. – The status of this species in North America requires further study.

Discussion. – *Lepraria leprolomopsis* most closely resembles *L. cryophila* in thallus morphology, particularly in having a thallus with marginal “lobes,” a well-developed hypothallus, and an underside with pale (rather than black) rhizohyphae. Despite their morphological similarity the species can be readily distinguished from *L. cryophila* by the production of atranorin and the stictic acid complex (P+ orange, C-, UV-) rather than divaricatic acid and nordivaricatic acid (P-, C+ red, UV+ blue-white). *Lepraria leprolomopsis* can further be separated from *L. cryophila* by the tendency of its thalli to grow along the plane of the substrate, resulting in flat margins. Thalli of *L. cryophila* often have strongly ascending margins that resemble shelves when viewed from the side.

Only five other species of *Lepraria* are known to produce atranorin and stictic acid: *L. elobata*, *L. finkii*, *L. lobificans*, *L. multiacida* Aptroot, and a chemotype of *L. neglecta*. Of these species, only *L. finkii* is known to occur in the same region as *L. leprolomopsis*. *Lepraria elobata* differs from the species by the production of zeorin and in having an aggregate thallus. *Lepraria finkii* is morphologically similar but typically lacks rhizohyphae and additionally produces zeorin in the thallus. *Lepraria lobificans* is chemically comparable but additionally produces roccellic/angardianic acid and has a pseudocorticate placodioid thallus that resembles *L. xerophila*. As has already been discussed in detail above (see entry for *L. finkii*) *L. lobificans* is not known to occur in the study area. *Lepraria multiacida* is a tropical species that is also morphologically similar to *L. leprolomopsis* but differs in the additional production of zeorin and dibenzofurans. *Lepraria neglecta* is a chemically variable species comprised of numerous chemotypes, one of which is chemically comparable to *L. leprolomopsis* but differs in the production of additional roccellic/angardianic acid. That species has an aggregate thallus with granules that are distinctly pseudocorticate and compact, at least in later stages of development.

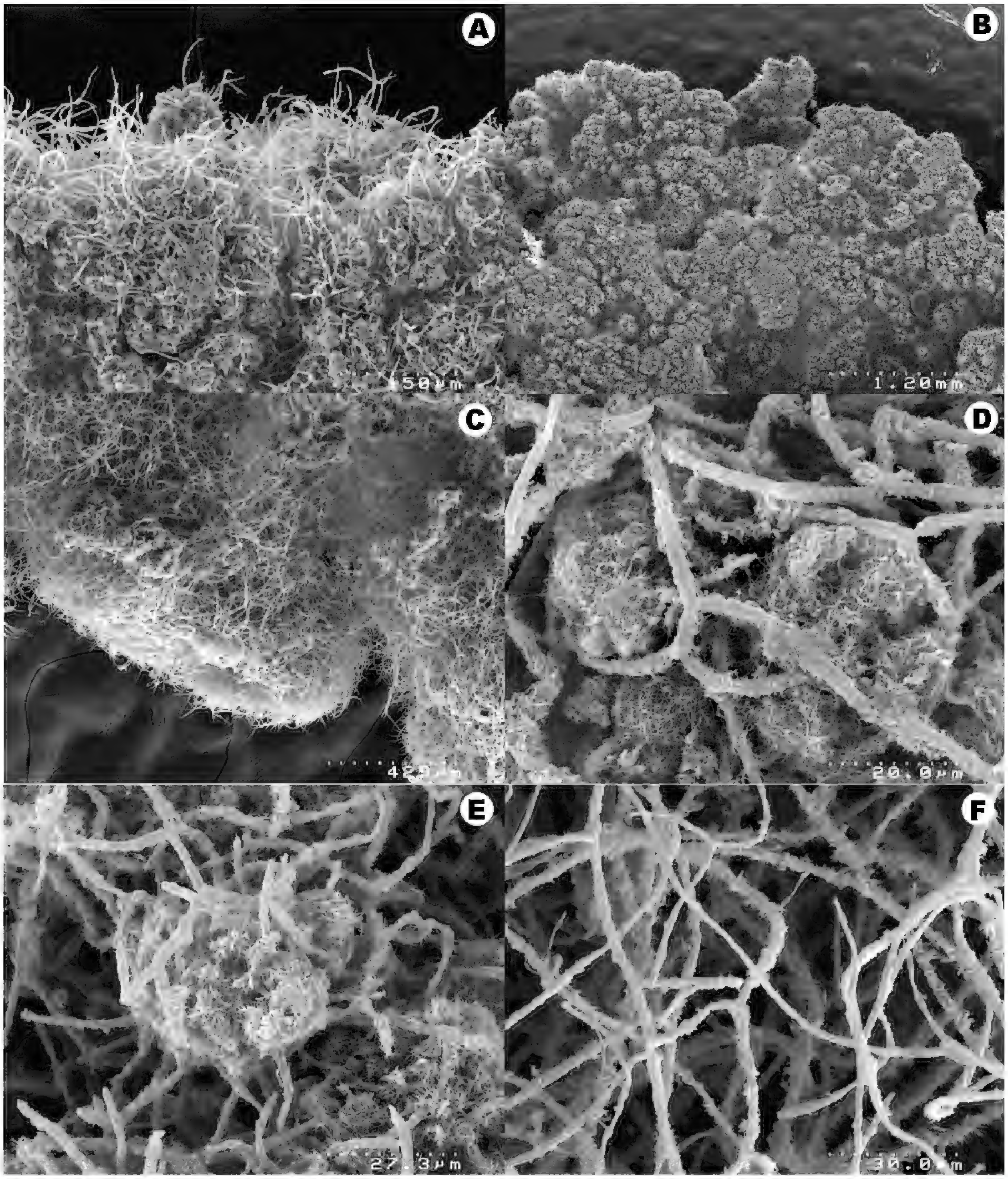

Figure 36, SEMs of *Lepraria leprolomopsis* (all from *Harris 28456* unless otherwise indicated). A, detail of thallus edge. B, gross morphology of thallus. C, detail of thallus edge from below (*Guccion 1663*). D, granules encased in network of thalline hyphae. E, young granule developing on thallus surface. F, detail of hyphae forming the hypothallus (*Guccion 1663*).

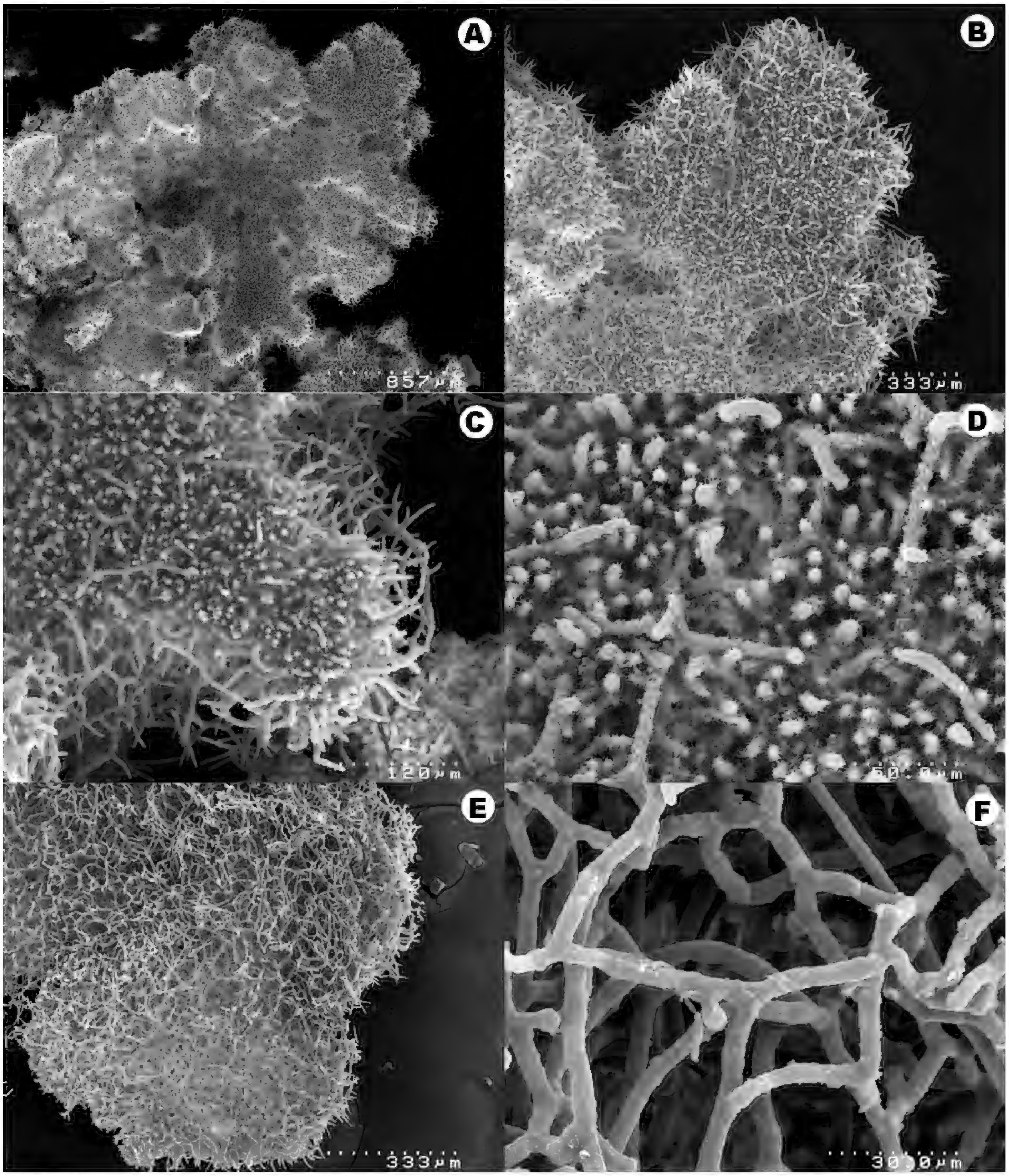

Figure 37, SEMs of *Crocynia pyxinoides* (all from *Lendemer 9067*, NY). A, gross morphology of thallus. B, detail of "lobe". C, detail of thallus margin illustrating both the upper surface and hypothallus extending outward from the underside of the "lobe" tips. D, detail of upper surface. E, thallus margin from below. F, detail of hyphae forming the hypothallus.

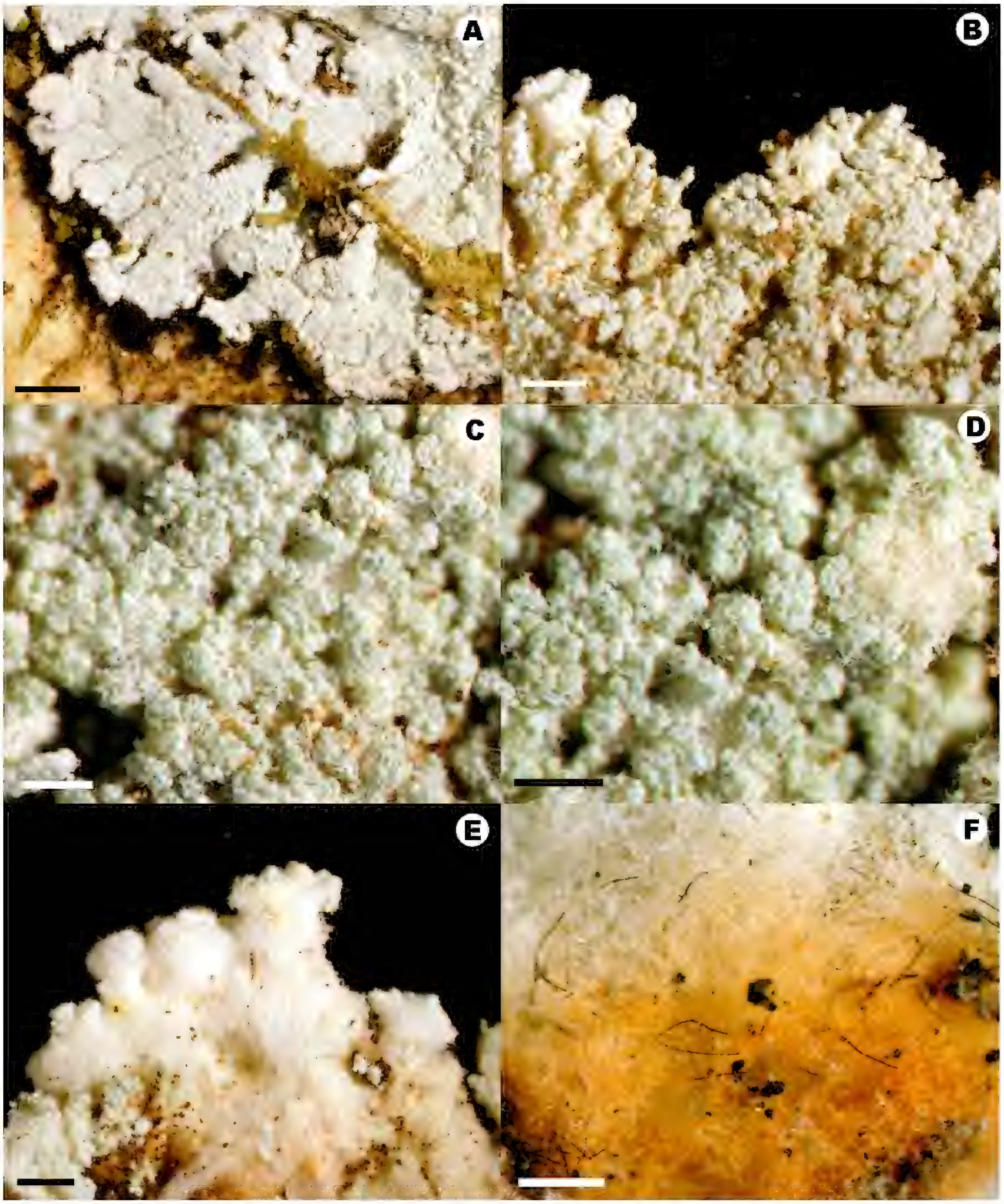

Figure 38, color illustrations of *Crocynia pyxinoides* (A) and *Lepraria leprolomopsis* (B–F). A, gross morphology of *C. pyxinoides*, note well developed black hypothallus surrounding the "lobes" (*Lendemer 9067*, scale = 2 mm). B, gross morphology of thallus of *L. leprolomopsis* (*Harris 28456* , scale = 2 mm). C–D, detail of supper surface and aggregations of granules (*Harris 28456*, scales = 0.25 mm). E–F, underside of thallus illustrating unpigmented margins (E) and pigmented portions near center of thallus (F) (both from *Guccion 1663*, scales = 1.0 and 0.5 mm respectively).

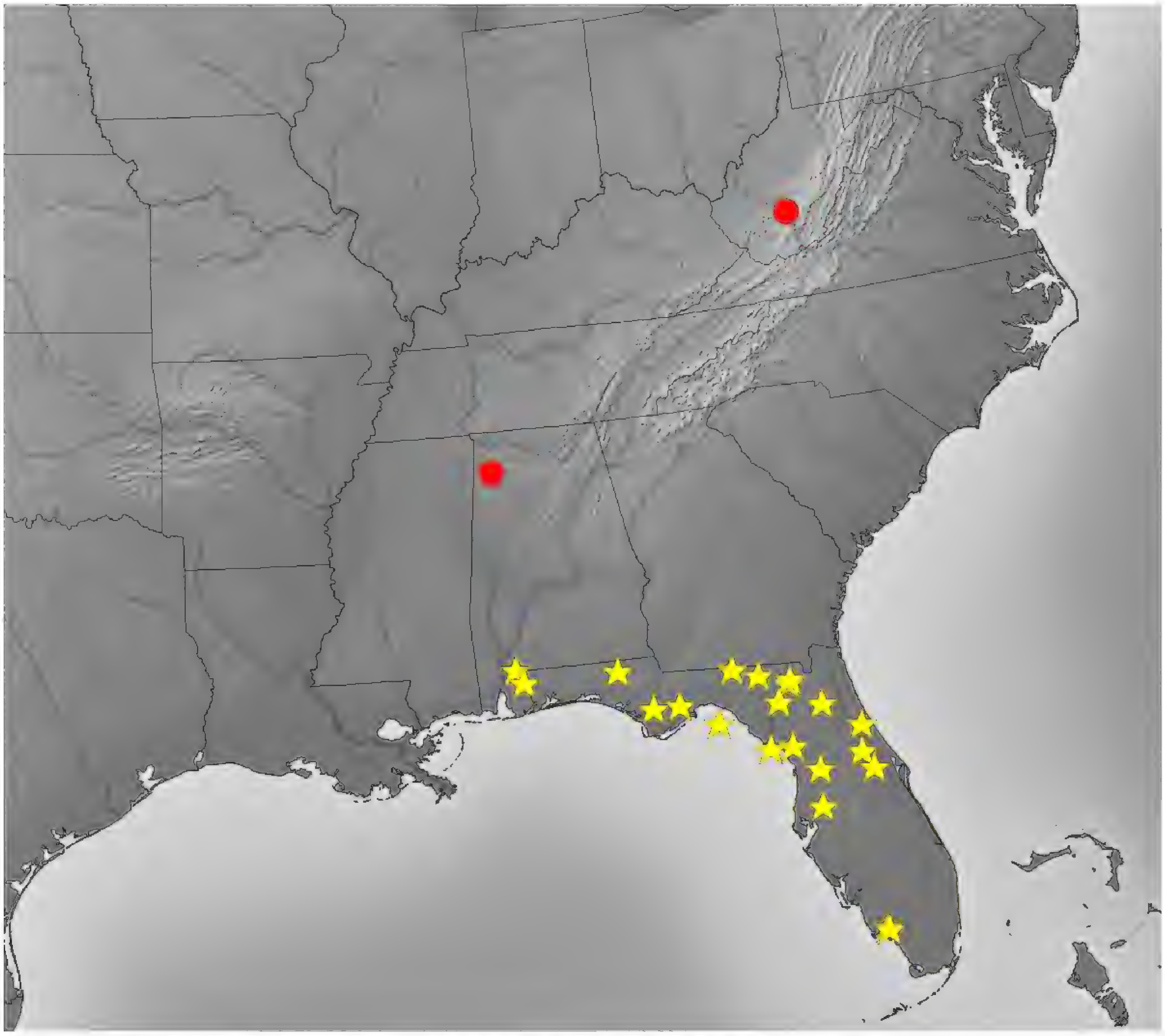

Figure 39, geographic distribution of *Lepraria leprolomopsis* (red dots) based on the specimens examined for this study compared to the distribution of *Crocynia pyxinoides* (yellow stars) based on herbarium specimens at NY.

Crocynia pyxinoides is another species that is likely to be confused with *Lepraria leprolomopsis* because it has a thick byssoid thallus that is typically sterile and produces atranorin and stictic acid (figures 37 and 38A). The two taxa are not presently known to be sympatric: *C. pyxinoides* is a corticolous species of the southern Coastal Plain while *L. leprolomopsis* is saxicolous and known only from two localities in the Appalachian Mountains (figure 39). They are also easily distinguished by thallus morphology: *C. pyxinoides* has a byssoid thallus with a black hypothallus, and elongate lobes that resemble a foliose lichen, whereas *L. leprolomopsis* has a leprarioid thallus with a white hypothallus, pale rhizohyphae, and lacks elongate lobes. Although both *C. pyxinoides* and *L. leprolomopsis* are chemically similar in producing both atranorin and stictic acid as their major secondary metabolites, the species appear to differ in the production of additional substances in the stictic acid complex. While *L. leprolomopsis* produces numerous substances in the stictic acid complex in high concentrations that can be detected with TLC, as well as trace amounts of norstictic and connorstictic acids, the specimens of *C. pyxinoides* examined produced only stictic acid in high enough concentration to be detected with TLC.

Additional specimens examined (4 total seen from North America). – **U.S.A. ALABAMA.** FRANKLIN CO.: Dismals Wonder Garden, just N of Hodges, 100–120 m, dry sandstone glade above, deeply cut, narrow sandstone ravines along small stream below, on rock, 26.ix.1992, *J.G. Guccion 1663* (NY), *1664* (hb. Guccion), *R.C. Harris 28456* (NY). **WEST VIRGINIA.** FAYETTE CO.: New River Gorge, vii.2001, on sandstone, *P. Clark N225Q7* (NY).

16) ***Lepraria membranacea*** **(Dicks.) Vain.,** Acta Soc. Fauna Flora Fenn. 49(2): 265. 1921.

Lichen membranaceus Dicks., Fasc. Pl. Crypt. Brit. 2: 21. 1790. TYPE: **SCOTLAND:** on humus over mountain rocks, *J. Dickson* (BM [n.v.], holotype).

Leproloma membranaceum (Dicks.) Vain., Term. Füz. 22: 293. 1899.

Crocynia membranacea (Dicks.) Zahlbr., Cat. Lich. Univers. 2: 575. 1923 [1924].

FIGURES 40 AND 41.

Description. – **Thallus** crustose, leprose, placodioid, without crisped margins, continuous and distinctly bi-layered, initially forming small discrete thalli which expand marginally, overlap, and become confluent to form a thick crust (0.2–0.4 mm thick), yellowish-white; **hyphae** hyaline, [1.4]–(2.0)–3.2–(3.6)–[4.8] µm (*n*=97), septate, secund, obscured by a layer of POL+ crystals that dissolve in KOH; **prothallus** disappearing with age; **hypothallus** a variably developed layer of densely intertwined hyphae surrounding and subtending the granules, sometimes outward from the edge of thallus; **rhizohyphae** uncommon, not pigmented; **granules** globose, [24]–(27)–41–(54)–[90] µm (*n*=90), ecorticate, well organized and discrete, often forming compound units, sometimes separating from the hypothallus and then producing abundant projecting hyphae; **photobiont** green, coccoid, cells globose, [6]–(7.1)–9.4–(11.8)–[15.6] µm (*n*=96).

Chemistry. – Pannaric acid, roccellic/angardianic acid, ± atranorin. Spot tests: K+ yellowish, C-, KC-, P- orange-red, UV-.

Ecology and distribution. – *Lepraria membranacea* is an uncommon species that is widespread in boreal eastern North America, with disjunct populations occurring in the central Appalachian Mountains (central and eastern Pennsylvania) (figure 41). The species is ecologically variable, although in the boreal forests it typically occurs on the bases of *Thuja* in cedar swamps. Populations have also been found growing on the bark of hardwoods and on sheltered non-calcareous rocks in humid microhabitats.

Based on my limited field studies in boreal eastern North America it appears that *Lepraria membranacea* is the least frequent species of the genus occurring in *Thuja* swamps. As such, the paucity of vouchers may be to due collector bias. Indeed, the ubiquity of *L. finkii* in such habitats can make it difficult to locate rare species without intensive sampling of what appear to be different entities in the field.

Conservation status. – Based on the available data *Lepraria membranacea* appears to be a rare species in North America, potentially worthy of conservation measures. Populations occurring in cedar swamps in the core northern geographic range of the species should be considered in management plans of those wetland habitats, as is the case of other similarly rare lichen species. Further study of this taxon is needed, however, to better estimate its frequency and abundance in its core range.

Discussion. – In the field *Lepraria membranacea* is most likely to be confused with *L. vouauxii* because both species have *finkii*-type placodioid thalli and distinctive yellowish colored thalli due to the presence of abundant dibenzofurans. *Lepraria vouauxii* is much more common than *L. membranacea* and is widely distributed in eastern North America. The two species can only be distinguished with certainly using TLC. *Lepraria membranacea* is also likely to be confused with other common sympatric species with *finkii*-type placodioid thalli, namely *L. finkii* and *L. eburnea*. The former species typically has a greenish-blue thallus and differs chemically in the production of atranorin, zeorin, and stictic acid. The latter species typically has a distinctive off-white thallus with a yellowish hue (not nearly as apparent as in the species that produce dibenzofurans), and differs chemically in the production of alectorialic acid rather than dibenzofurans.

Selected specimens examined (17 total seen from North America). – **CANADA. ONTARIO.** NIPPISING DIST.: Algonquin Provincial Park, below Barron Canyon walking trail, 8.viii.2010, on *Thuja*, *C. Lewis 450* (NY). **QUEBEC.** GATINEAU CITY: Gatineau Park, Trail 05, 0–0.5 mi N of parking area behind Asticou Center, 22.v.2011, on *Quercus, J.C. Lendemer 28306-A & C. Freebury* (NY). KAMOURASKA CO.: Sainte-Anne de la Pocatière, 13.iv.1935, on hemlock, *E. Lepage 131* (NY). **GERMANY:** Niederbayern, Kreis Regen, 22.x.1997, on *Acer*, *K. Kalb s.n.* (NY) **SPAIN. ASTURIAS:** Villanueva, ~8 km SW of La Florida, 4.viii.1987, on rock, *W.R. Buck 15003* (NY). **U.S.A. NEW YORK.**

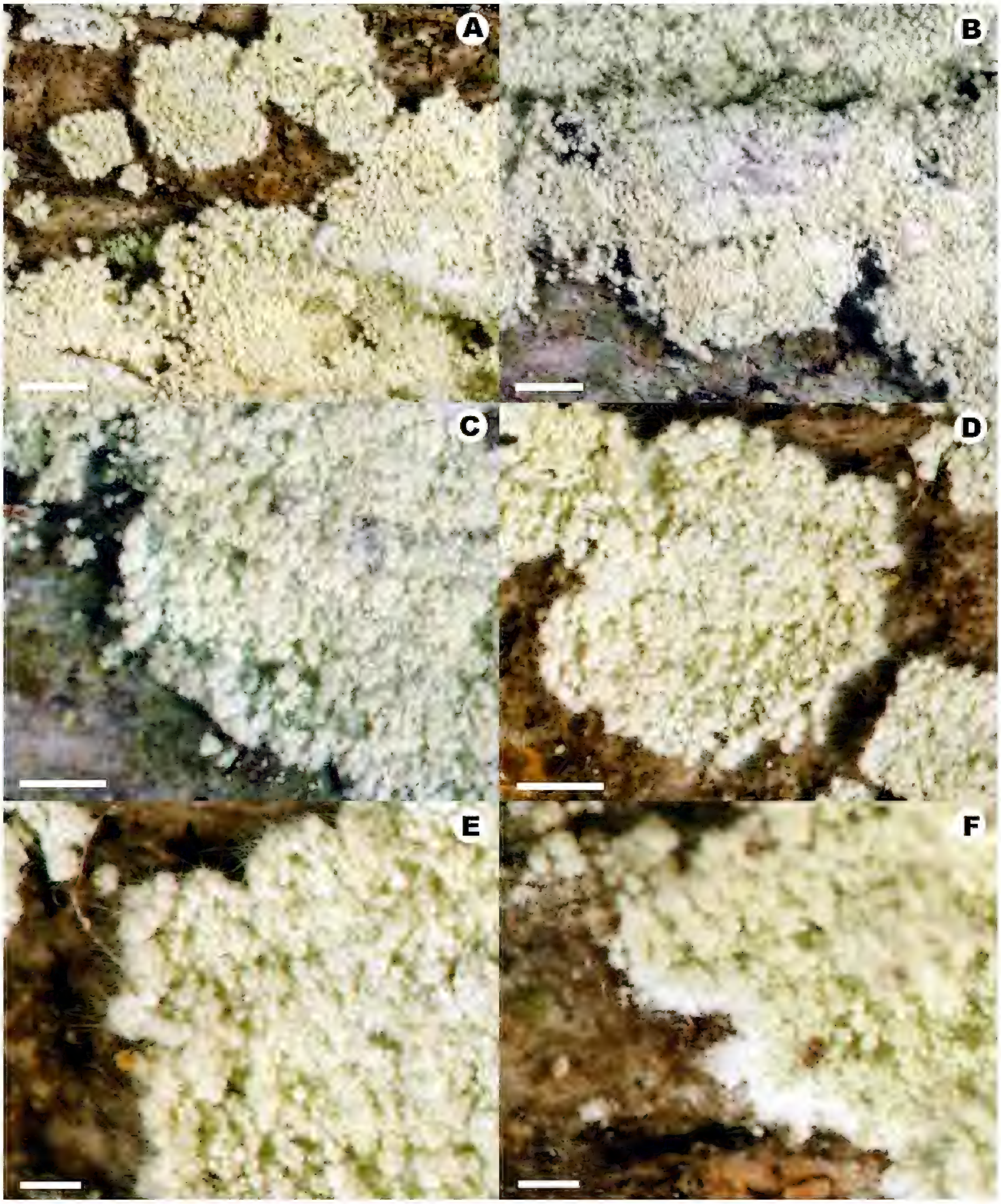

Figure 40, *Lepraria membranacea* (all from *Lewis 450*). A–B, macromorphology of the thallus (scales = 1.0 mm). C–D, detail of the thallus (scales = 0.5 mm). C, detail of the granules and thallus edge (scale = 0.25 mm). F, section of the thallus illustrating thick white hypothallus (scale = 0.25 mm).

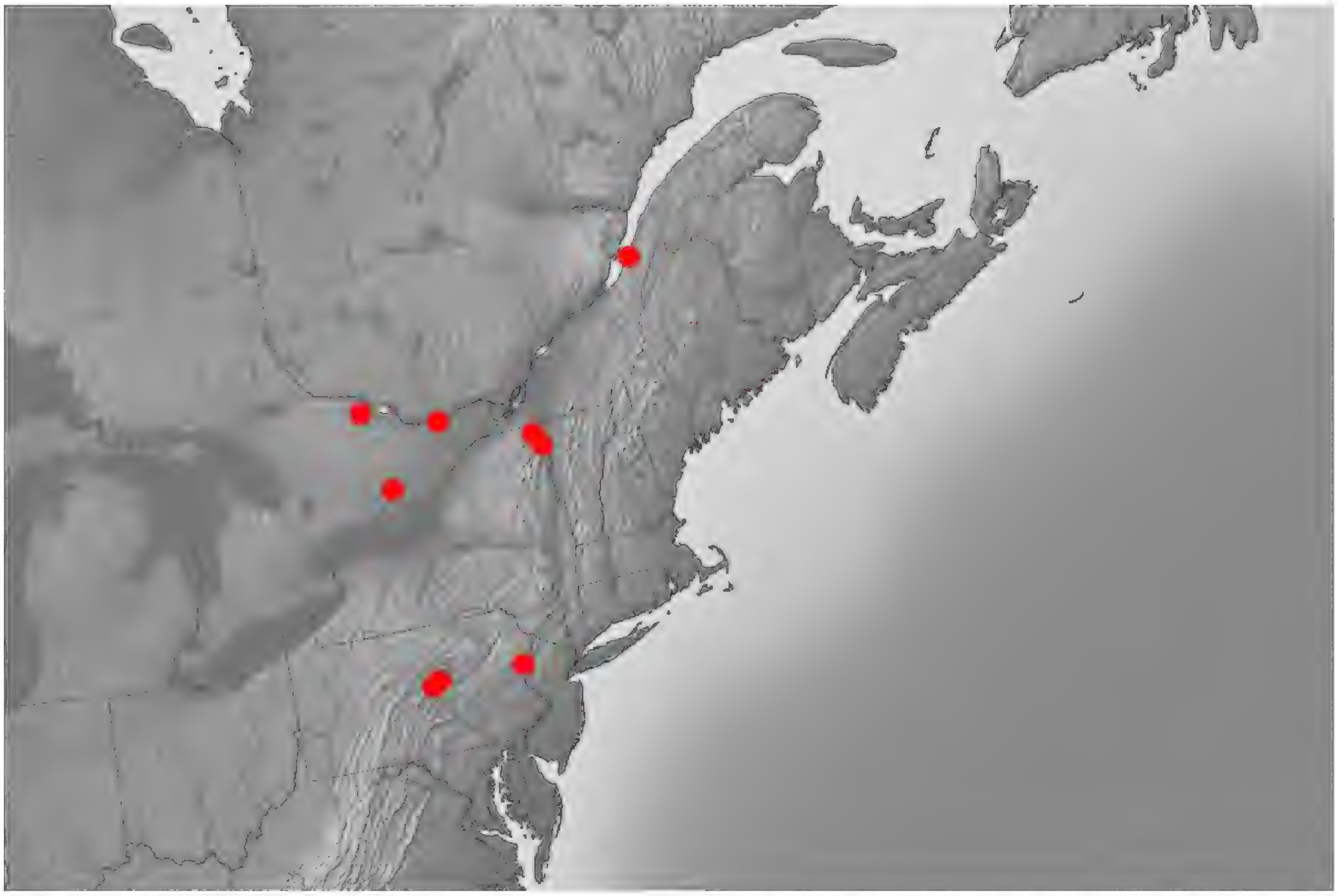

Figure 41, geographic distribution of *Lepraria membranacea* based on the specimens examined for this study.

CLINTON CO.: Town of Altona, Altona Flat Rock area in Miner Experimental Forest, 19.x.1996, on rock, in overhang, *R.C. Harris 39138* (NY); Town of Peru, Valcour Island in Lake Champlain, Bluff Point, 18.v.2007, on *Thuja*, *R.C. Harris 53541* (NY). **PENNSYLVANIA.** CENTRE CO.: Bald Eagle State Forest, Stony Run Rd., 0.5 mi N of jct w/ Negro Hollow Rd., 14.ix.2010, on *Quercus*, *J.C. Lendemer 25547* (NY). MONROE CO.: Delaware Water Gap National Recreation Area, Mount Minsi, 3.v.2006, on shaded sandstone, *J.C. Lendemer 6803 & N. Howe* (NY).

17) *Lepraria neglecta* (Nyl.) Erichsen, Flechtenfl. Nordwestdeustchl. 394. 1957.

Lecidea neglecta Nyl., Not. Sällsk. Fauna Fl. Fenn. Förh., N. Ser. 1: 233. 1859. TYPE: **FINLAND:** Uusimaa, near Helsinki, 1858, on small moss cushions covering granitic rocks, *W. Nylander s.n.* (H [n.v.], lectotype [selected by Laundon 1992]).

Crocynia neglecta (Nyl.) Hue, Bull. Soc. Bot. France 81: 376. 1924.

Crocynia alpina B. de Lesd., Bull. Soc. Bot. France 61: 85. 1914 . TYPE: **U.S.A. COLORADO.** LARIMER CO.: Rocky Mountain National Park, Toll Pass, 12050 ft, alpine tundra, in snow accumulation sites with good drainage, 21.viii.1979, *Willard s.n. = Lich. Exs. COLO 609* (UPS [n.v.], neotype [selected by Baruffo et al. 2006]; COLO!, DUKE!, FH!, NY!, isoneotypes).

Lepraria alpina (B. de Lesd.) Tretiach & Baruffo *in* Baruffo et al., Nova Hedwigia 83: 390. 2006.

Lepraria alpina var. *zeorinica* L. Saag, Mycotaxon 102: 68. 2007. TYPE: **GREENLAND:** Qingertivaq, 550 m, 30.vii.1970, on mosses and soil (humus), *E. Hansen ESH-70.0032* (C [n.v.], holotype; TU [n.v.], isotype).

Lepraria zeorinica (L.) Kukwa, Mycotaxon 108: 361. 2009.

Lepraria angardiana Øvstedal, Nova Hedwigia 37: 687. 1983. TYPE: **ANTARCTICA:** Dronning Maud Land, Sverdrupfjella, Sørhausane, 31.xii.1970, on soil, *Angard s.n.* (BG [n.v.], holotype).

Leproloma angardianum (Øvstedal) J.R. Laundon, Lichenologist 21: 19. 1989.

Lepraria borealis Loht. & Tønsberg *in* Lohtander, Ann. Bot. Fenn. 31: 224. 1994. TYPE: **NORWAY. NORD-TRØNDELAG:** Namsskogan, Børgefjell Nat. Park, Namskroken, N bank of river Namsen E of Mattisflya, 340 m, 23.viii.1975, muscicolous on rock, *T. Tønsberg 1519* (BG!, holotype; H!, isotype).

Lepraria cacuminum sensu Lohtander, Ann. Bot. Fenn. 32: 52. 1995.
Leproloma cacuminum sensu Laundon, Lichenologist 24: 345. 1992.

Crocynia caesioalba B. de Lesd., Bull. Soc. Bot. France 61: 84. 1914. TYPE: **FRANCE:** Seine-et-Marne, Forêt de Fontainebleau, Jul 1913, very common on mosses and lichens on sandstone rocks, *Bouly de Lesdain* s.n. (E [n.v.], holotype; BM, GL, PC [all n.v.], isotypes).
Leproloma caesioalba (B. de Lesd.) M. Choisy, Bull Mens. Soc. Linn. Lyon 19: 12. 1950.
Lepraria caesioalba (B. de Lesd.) J.R. Laundon, Lichenologist 24: 324. 1992.

Lepraria caesioalba var. *groenlandica* L. Saag, Mycotaxon 102: 73. 2007. TYPE: **GREENLAND:** Qaanaaq, Thule, 28.vi.1986, on soil (humus) and mosses, *E. Hansen ESH-86.0321* (C [n.v.], holotype; TU [n.v.], isotype).

Lepraria gelida Tønsberg & Zhurb., Graphis Scripta 18: 64. 2006. TYPE: **NORWAY. SVALBARD:** Spitzbergen, SSE of Wijdefjorden, E of Austfjorden, SE of Finnekroken, the W-facing foothills of Finlandsveggen, 20–30 m, 5.vii.2002, on slightly sloping ground in *Dryas octopetala* heath, *T. Tønsberg 31049* (BG!, holotype).

Lepraria svalbardensis Tønsberg *in* Øvstedal et al., Sommerfeltia 33: 213. 2009. TYPE: **NORWAY. SVALBARD:** Spitsbergen, the W-facing foothill of Mt. Platåberget, uphill from the road between Longyearbyen and Bjørndalen, 70–75 m, 26.vi.2003, muscicolous in dry niche in scree, *T. Tønsberg 31851* (BG [n.v.], holotype; UDGA [n.v.], isotype).

Lepraria zonata Brodo, Bull. New York State Mus. Sci. Surv. 410: 263. 1968. TYPE: **U.S.A. NEW YORK.** SUFFOLK CO.: Wading River, 11.viii.1962, on vertical surface of partially shaded boulder, *I.M. Brodo 3869* (MSC!, holotype).

FIGURES 42 AND 43.

Description. – **Thallus** crustose, leprose, aggregated, discontinuous and not stratified, initially composed of isolated granules that divide to form aggregations, eventually merging to form a thin crust (<0.1 mm thick), gray-blue to blue-white in color; **hyphae** hyaline, [1.8]–(2.3)–2.9–(3.4)–[4.8] µm (*n*=96) in width, septate, secund, obscured by a thick layer of POL+ crystals that dissolve in KOH; **prothallus** persistent; **hypothallus** absent; **rhizohyphae** absent; **granules** globose to subglobose, typically [30]–(42)–59–(77)–[102] µm (*n*=131) in diameter however some forms with *alpina*-type thalli develop large granules (>1.0 mm in diameter), initially ecorticate but quickly developing a pseudocortex of gelatinized hyphae, well organized and discrete, remaining distinct and not forming compound units; **photobiont** green, coccoid, cells globose, [4.8]–(7.2)–9.4–(11.7)–[15.6] µm (*n*=96) in width.

Chemistry. – As has been summarized by Lendemer (in press.) the chemical variation within *Lepraria neglecta* is very complex. The following chemotypes are present in North America. Chemotype 1 (*L. neglecta* s. str.): roccellic/angardianic acid, alectorialic acid, ± atranorin (tr.); spot tests: K+ yellow, C-, KC+ red, P+ yellow, UV-. Chemotype 2 (*L. borealis* and an unnamed chemotype): atranorin, ± roccellic/angardianic acid, ± rangiformic/jackinic acid; spot tests: K+ yellow, C-, KC-, P+ weak yellowish, UV-. Chemotype 3 (*L. caesioalba* and an unnamed chemotype): atranorin, fumarprotocetraric acid, ± roccellic/angardianic acid, ± rangiformic/jackinic acid; spot tests: K+ yellow, C-, KC-, P+ orange-red, UV-. Chemotype 4 (unnamed chemotype): atranorin, norstictic acid agg.; spot tests: K+ yellow turning dirty red, C-, KC-, P+ orange, UV-. Chemotype 5 (*L. alpina*): atranorin, roccellic/angardianic acid, porphyrilic acid; spot tests: K+ yellow, C-, KC-, P+ weak yellowish, UV-. Chemotype 6 (unnamed chemotype): atranorin, psoromic acid, ± roccellic/angardianic acid, ± rangiformic/jackinic acid; spot tests: K+ yellow, C-, KC-, P+ yellow, UV-. Chemotype 7 (*L. svalbardensis* and other chemotypes): atranorin, stictic acid agg., ± zeorin, ± roccellic/angardianic acid, ± rangiformic/jackinic acid; spot tests: K+ yellow, C-, KC-, P+ orange, UV-.

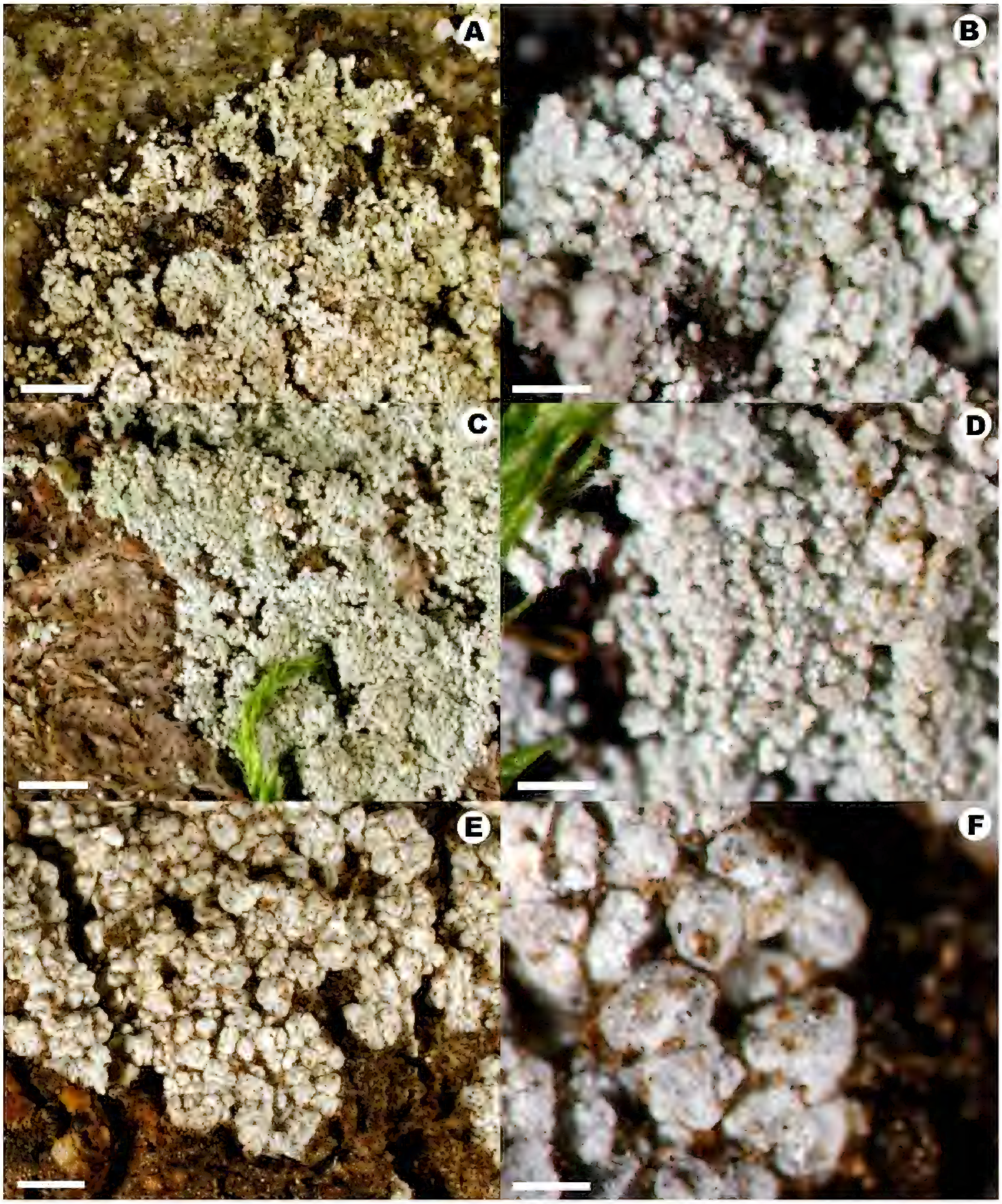

Figure 42, *Lepraria neglecta*, comparison of a saxicolous population (A–B, *Lendemer 24995*), a corticolous population (C–D, *Lendemer 23717*), and a population with an *alpina*-type thallus (E–F, *Buck 55113*). A, C and E, macromorphology of the thallus, note the tendency to form radiating rosettes (scales = 1.0 mm). B, D and F, detail of the granules (scales = 0.25 mm).

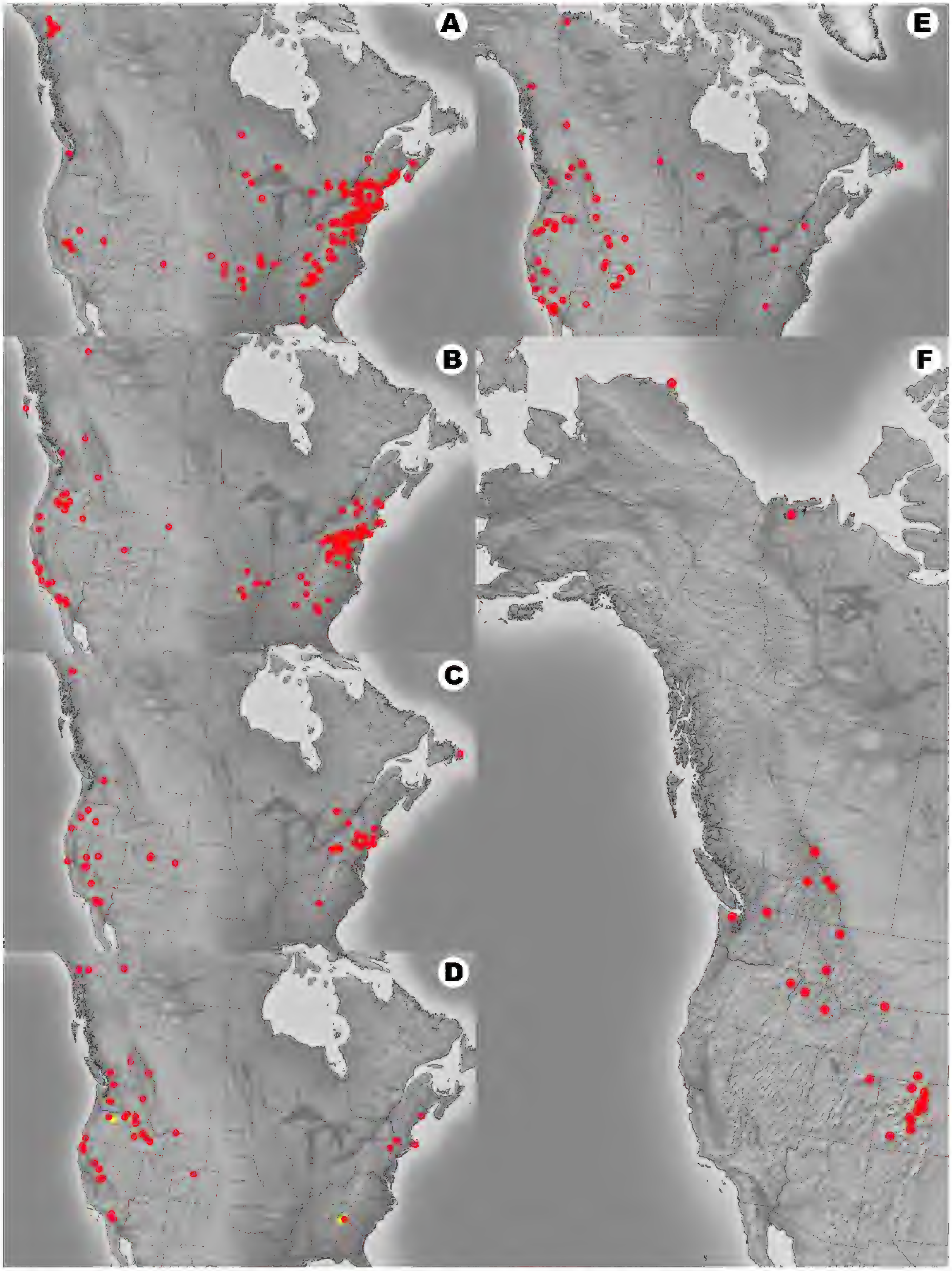

Figure 43, geographic distributions of the chemotypes of *Lepraria neglecta* in North America based on specimens examined for this study. A, alectorialic acid chemotype (*L. neglecta* s.str.). B, fumarprotocetraric acid chemotype. C, psoromic acid chemotype. D, stictic acid (red dots) and norstictic acid (yellow dots) chemotypes. E, fatty acid chemotypes. F, porphyrilic acid chemotype.

Ecology and distribution. – *Lepraria neglecta* is common and widely distributed throughout northern temperate, boreal and arctic regions of North America, extending southward in mountain regions throughout the continent (figure 43). The species occurs on many substrates in exposed habitats that lack calcareous influences, including soil, organic matter, bryophytes and non-calcareous rocks. Corticolous populations are also frequently encountered in humid habitats in open forests throughout eastern North America.

Conservation status. – This taxon is common and widespread throughout North America and likely does not represent a conservation concern. Many of the chemotypes are also widespread, although not necessarily common (see below for number of specimens of each chemotype examined). Together with *Lepraria finkii* this is one of the most common species of the genus, including in disturbed habitats.

Discussion. – The chemical variation found within *Lepraria neglecta* is unparalleled in *Lepraria.* Nonetheless molecular data suggest that there is not support for the continued taxonomic recognition of these chemotypes as distinct taxa (Lendemer in press.). This species can potentially be confused with many other sympatric species of *Lepraria* that have aggregate thalli. All those species however, occur in sheltered or protected habitats and have ecorticate granules with a fluffy appearance rather than granules that develop a thick pseudocortex, appearing compact and hard (Lendemer 2011a). Among the species that be confused with *L. neglecta*, the two most similar species are *L. caesiella* and *L. elobata*. In temperate eastern North America *L. caesiella* is most likely to be confused with *L. neglecta* as both species occur on a variety of substrates (e.g., rock, hardwoods, conifers) and have aggregate thalli. *Lepraria caesiella* is usually easy to distinguish morphologically from *L. neglecta* due to the absence of a pseudocortex on the granules which gives the thallus a cottony or fuzzy appearance. It also differs chemically from most known chemotypes of *L. neglecta* in the production of zeorin in addition to atranorin. Only the chemotype of *L. neglecta* that produces atranorin and zeorin, previously recognized as *L. zeorinica*, is chemically comparable to *L. caesiella*. In northern North America and montane regions of western North America, *L. neglecta* is likely to be confused with *L. elobata*. That species is typically easily recognized by its granules which appear fuzzy due to the absence of pseudocortex and the production of zeorin together with atranorin and stictic acid. A chemotype of *L. neglecta* that is chemically comparable to *L. neglecta* is known from California but it differs from *L. elobata* morphologically in having granules with a pseudocortex, and ecologically in occurring in an exposed habitat.

Lepraria humida and *L. jackii* are also likely to be confused with *L. neglecta*, especially when found growing at the same site. As is the case for *L. caesiella* and *L. elobata*, both *L. humida* and *L. jackii* differ noticably from *L. neglecta* in the absence of a pseudocortex and occurrence in sheltered or protected habitats. *Lepraria humida* is particularly likely to be confused with *L. neglecta*, however rather than having thalli that form rosettes the thalli of *L. humida* tend to form dispersed piles of granules that resemble islands. Thalli of *Lepraria jackii* also do not form rosettes, but rather form a continuous crust with diffuse margins.

Selected specimens examined [237 total seen from North America; alectorialic acid chemotype, Chemotype 1]. – **CANADA. ONTARIO.** KENORA DISTR.: 47 km SE of Sandy Lake airport, ~4 km SSE of McKendry Lake, 7.vii.2011, on rock, *M.J. Oldham 39071* (NY). LANARK CO.: 0–0.2 mi N Peneshula Rd., 21.v.2011, on sheltered rock, *J.C. Lendemer 28209 & R.E. Lee* (NY). LEEDS CO.: Lake Opinicon, Eight Acre Island, 11.v.1967, *W.P. Yan 215* (COLO). NIPISSING DIST.: Algonquin Provincial Park, E shore of Carl Wilson Lake, 31.vii.2011, on rock, *I.M. Brodo et al. 33055* (CANL). **NEW BRUNSWICK.** CHARLOTTE CO.: Caughey-Taylor Nature Preserve, 2.v.2011, on moss over rock, *R.C. Harris 56780* (NY). **NORTHWEST TERRITORIES:** MACKENZIE DIST.: Mackenzie Mts., Nahanni National Park, Tlogotsho Plateau, 11.vii.1977, on mosses over sandstone boulders, *T. Ahti 32694* (H, NY). **NOVA SCOTIA.** COLCHESTER CO.: Economy River Wilderness Area, vicinity of Economy Falls, 14.v.2004, on mosses over rock, *T. Ahti 62445a* (H). YARMOUTH CO.: Flintstone Rock, 8.v.1999, on *Parmelia saxatilis* over rock, *R.C. Harris 42975-A* (NY). **QUEBEC.** GATINEAU CO.: Gatineau Park, near Ramsey Lake, 30.vii.1978, *T. Ahti 34649 & I.M. Brodo* (H, NY). **U.S.A. ARKANSAS.** PERRY CO.: Ouachita National Forest, vicinity of Goat Bluff, 6.x.2010, on rock in overhang, *J.C. Lendemer et al. 26073* (NY). **CALIFORNIA.** MARIPOSA CO.: Yosemite National Park, S shore of Merced River, 20.ix.2009, on rock, *J.C. Lendemer 19635* (NY). **CONNECTICUT.** LITCHFIELD CO.: Town of Canaan, Great Mountain

Forest, 20.ix.2003, on log, *R.C. Harris 48028* (NY). **FLORIDA.** WASHINGTON CO.: Rock Hill, 30.ix.1994, on rock, *R.C. Harris 35580* (NY). **GEORGIA.** FANNIN CO.: Cohutta Mountains, 3.vii.2009, on *Liriodendron*, *M. Hodges 4327* (NY). **ILLINOIS.** POPE CO.: Shawnee National Forest, Hayes Creek, 16.x.1993, *R.C. Harris 31370* (NY). **KANAS.** ELLSWORTH CO.: Kanopolis State Park, 27.iv.2006, on *Cladonia* over rock, *C.A. Morse 12732 & C.C. Freeman* (NY). GREENWOOD CO.: 1 mi N, 5 mi E of the town of Fall River, 30.iii.2003, on sandstone, *M.K. Advaita 3059* (KANU). **KENTUCKY.** ESTILL CO.: Daniel Boone National Forest, ~1.5 mi NE of Cottage Furnace Campground, 11.x.1995, on sandstone, *R.C. Harris 36962* (NY). **MARYLAND.** ANNE ARUNDEL CO.: Wishing Rock, 28.iii.1963, on rock, *C.F. Reed 55089* (NY). **MAINE.** WASHINGTON CO.: Town of Cutler, Cutler Coastal Public Lands, 8.vi.2010, on humus over rock, *J.C. Lendemer 22688* (NY). **MASSACHUSETTS.** BERKSHIRE CO.: Town of Pittsfield, Pittsfield State Forest, 4.vi.2010, on rock, *J.C. Lendemer 22466* (NY). ESSEX CO.: Lynn Woods, 23.ix.1978, on *Quercus*, *M.A. Sherwood s.n.* (FH). NORFOLK CO.: Milton, x.1978, on rocks, *M.A. Sherwood & E. Kneiper s.n.* (FH). WORCESTER CO.: Holden, 20.ix.1966, on rock, *T.B. Kinraide s.n.* (COLO). **MISSOURI.** IRON CO.: Ketcherside Mountain Conservation Area, 26.iii.2006, on rhyolite, *J.C. Lendemer et al. 6105* (NY). **NEW HAMPSHIRE.** COOS CO.: Mt. Washington, 31.viii.1933, on rock, *G.P. Anderson s.n.* (NY). **NEW JERSEY.** WARREN CO.: Jenny Jump State Forest, 11.ix.1992, on rock, *W.R. Buck 21544* (NY). **NEW YORK.** HERKIMER CO.: Little Falls, Moss Island, 14.vi.2011, on rock, *R.C. Harris 56805* (NY). **NORTH CAROLINA.** SWAIN CO.: Great Smoky Mountains National Park, along Balsam Mountain Road, 6.viii.2009, on rock in overhang, *J.C. Lendemer 19149 & E.A. Tripp* (NY). **OHIO.** PORTAGE CO.: West Branch State Park, 10.iii.1990, on sandstone, *S.J. Mazzer 37099* (NY). **OKLAHOMA.** OSAGE CO.: Woolaroc Wildlife Preserve, start of nature trails area, 6.iv.2007, on sandstone, *C.A. Morse 14610 & D. Ladd* (KANU). **PENNSYLVANIA.** CARBON CO.: State Game Lands No. 129, 19.v.2009, on *Acer*, *J.C. Lendemer 17453 & R.C. Harris* (NY). **RHODE ISLAND.** PROVIDENCE CO.: Town of Lincoln, Lime Rock Nature Preserve, 17.ix.2006, on rock, *R.C. Harris 53209* (NY). **TENNESSEE.** CARTER CO.: Roan Mountain, Carver's Gap, 6.x.1985, on mosses over rock, *R.C. Harris 18342* (NY). **VERMONT.** ORLEANS CO.: Town of Westmore, Willoughby State Forest, 18.x.2010, on *Betula*, *J.C. Lendemer 27114 & M. Sundue* (NY). **VIRGINIA.** WISE CO.: Jefferson National Forest, High Knob, 13.ix.1991, on *Quercus*, *R.C. Harris 26973* (NY). **WEST VIRGINIA.** POCAHONTAS CO.: Monongahela National Forest, vic. Blue Knob, 20.x.2007, on *Acer*, *J.C. Lendemer 9937 & A. Moroz* (NY).

Selected specimens examined [85 total seen from North America; depside deficient chemotype, Chemotype 2]. – **CANADA. ONTARIO.** BRUCE CO.: Bruce Alvar Nature Reserve, 26.ix.2010, on glacial erratic, *R.C. Harris 56539* (NY). **U.S.A. ARIZONA.** YAVAPAI CO.: Coconino National Forest, W-facing slopes of Doe Mountain, 7.iii.2010, on soil in crevice, *J.C. Lendemer 21817 & A. Moroz* (NY). **CALIFORNIA.** RIVERSIDE CO.: San Bernardino National Forest, San Jacinto Mountains, vicinity of Boxwood Spring, 11.i.2008, on rock, *J.C. Lendemer 11488 & K. Knudsen* (NY). SAN DIEGO CO.: Palomar Mountain, Palomar State Park, near Upper Doane Valley, 20.iv.2005, on granite, *K. Knudsen 2716 & L. Glacy* (FH, NY). SAN LUIS OBISPO CO.: along road to Black Mountain 4.8 km above jct w/ Park Hill Rd., 13.xi.2011, on moss over rock, *S. Sharnoff 4019* (UCR). **COLORADO.** BOULDER CO.: base of First Flatiron, S of mouth of Gregory Canyon, 14.viii.1977, on bryophytes, *W.A. Weber L-65138 & P.M. Jørgensen* (COLO). HINSDALE CO.: Mesa Seco, near Slumgullion Pass, 27.vii.1964, on soil, *W.A. Weber L-38511* (COLO). LARIMER CO.: Mummy Range, Mt. Chiquita, 25.vii.1962, on humus, *R.A. Anderson 2914* (COLO). **MONTANA.** GLACIER CO.: Glacier National Park, Wynn Mountain, 28.viii.1954, on soil, *W.S. Osburn s.n.* (COLO). **NEW YORK.** ESSEX CO.: Whiteface Mtn., 28.ix.1989, on rock, *C.C. Bratt 6645* (NY). **NORTH CAROLINA.** JACKSON CO.: Nantahala National Forest, Chattooga Wild and Scenic River/Ellicott Rock Wilderness, 18.ix.2006, on granite, *J.C. Lendemer et al. 7882* (NY). **OREGON.** KLAMATH CO.: Crater Lake National Park, Mazama Rock, ix.1961, on rock, *F.P. Sipe 1424* (COLO). UNION CO.: just W of Starkey Experimental Forest, 21.v.2006, on *Grimmia*, *B. McCune 28216* (NY, OSC). **VERMONT.** ADDISON CO.: Green Mountain National Forest, Lincoln Gap, 14.viii.1971, on rock, *R.S. Egan 3344* (GZU).

Selected specimens examined [227 total seen from North America; fumarprotocetraric chemotype, Chemotype 3]. – **CANADA. BRITISH COLUMBIA:** Moresby Island, Takakia Lake, 4.vii.1967, on mosses over rock, *I.M. Brodo 10932 & M.J. Shchepanek* (NY). **U.S.A. ARKANSAS.** IZARD CO.: Calico Rock, 26.iv.1988, on rock, *R.C. Harris 21679* (NY). **CALIFORNIA.** RIVERSIDE CO.: Santa Jacinto

Mountains, above Pacific Crest Trail, 8.v.2005, on granite, *K. Knudsen 2838 & J.C. Lendemer* (NY, UCR). TRINITY CO.: 3 mi SW of Douglas City, 21.iv.1965, on rock, *W.A. Weber s.n.* (NY). **CONNECTICUT.** FAIRFIELD CO.: Town of Redding, Highstead Arboretum, 9.vi.2005, on *Quercus*, *R.C. Harris 51565* (NY). **GEORGIA.** WALKER CO.: Chattahoochee National Forest, Johns Mountain Overlook, 23.ix.1992, on bark, *R.C. Harris 28239* (NY). **IDAHO.** BONNER CO.: Clark Fork, 9.vii.1981, on moss, *C.C. Bratt 2678* (NY, SBBG). **ILLINOIS.** JOHNSON CO.: Shawnee National Forest, Simpson Township's Barrens, 16.x.1993, on rock, *R.C. Harris 31330* (NY). **KENTUCKY.** ESTILL CO.: Daniel Boone National Forest, ~1.5 mi NW of Cottage Furnace Campground, 11.x.1995, on rock, *R.C. Harris 36884* (NY). **MAINE.** OXFORD CO.: East Buckfield, 18.v.1933, on *Ptilidium*, *J.C. Parlin 11738* (NY). **MARYLAND.** GARRETT CO.: High Bog, 24.ix.1989, on rock, *R.C. Harris 24579* (NY). **MASSACHUSETTS.** BRISTOL CO.: Norton, 2.xii.1936, on conglomerate, *M. Rice s.n.* (NY). **MISSOURI.** MONTGOMERY CO.: Graham Cove State Park, 27.x.2010, on rock, *R.C. Harris 45740* (NY). **NEW JERSEY.** BERGEN CO.: Ramapo, 8.xi.1942, on rock, *W.H. Wiegmann s.n.* (NY). **NEW YORK.** ROCKLAND CO.: Bear Mountain State Park, Iona Island Bird Sanctuary, 18.vii.2010, on *Quercus*, *J.C. Lendemer 23666 & A. Moroz* (NY). **OREGON.** CROOK CO.: Biak Training Center, v.2009, on soil and moss, *B. McCune 29967* (NY). DESCHUTES CO.: Juniper Wayside, Hwy 20 7 mi E of Sisters, 15.viii.1978, on mosses, *M.A. Sherwood & L.H. Pike s.n.* (CANL, COLO). **PENNSYLVANIA.** CENTRE CO.: Bald Eagle State Forest, above Winkleblech Vista, 14.ix.2010, on *Quercus*, *J.C. Lendemer 25481* (NY). VENANGO CO.: 1 mi E of Barkeyville, 16.iii.1957, on rock, *H.N. Mozingo 524* (COLO). **SOUTH CAROLINA.** ABBEVILLE CO.: Sumter National Forest, Parsons Mountain, 17.iii.1997, on rock, *R.C. Harris 40320* (NY). **TENNESSEE.** SEVIER CO.: Gatlinburg, vi.1935, on rock, *A.J. Sharp s.n.* (NY). **UTAH.** UINTAH CO.: Ashley National Forest, along FS 104, 30.vii.2009, on rock, *W.R. Buck 55078* (NY). **VERMONT.** ADDISON CO.: Green Mountain National Forest, Bristol Cliffs Wilderness Area, 20.x.2010, on rock, *J.C. Lendemer 27394 & M. Sundue* (NY). **VIRGINIA.** PAGE CO.: Hawksbill Mountain, 8.vi.1936, on rock, *G.P. Anderson s.n.* (NY). **WEST VIRGINIA.** TUCKER CO.: Monongahela National Forest, Olsen's Bog, 22.iv.2001, on *Magnolia*, *R.C. Harris 44869* (NY).

Specimens examined [2 total seen from North America; norstictic chemotype, Chemotype 4]. – **U.S.A. GEORGIA.** LUMPKIN CO.: Desoto Falls, 9.vii.2010, on rock, *S.Q. Beeching 9893* (NY). **OREGON.** WHEELER CO.: Blue Mountains, Shelton Wayside Campground, v.2008, on rhyolite, *B. McCune 29620* (NY).

Selected specimens examined [34 total seen from North America; porphyrilic chemotype, Chemotype 5]. – **U.S.A. COLORADO.** BOULDER CO.: Rocky Mountain National Park, Wild Basin, vicinity of Thunder Lake, 11-12.viii.1961, on humus, *R.A. Anderson 1648* (COLO). CHAFFEE CO.: San Isabel National Forest, Cottonwood Pass, 18.viii.1983, on soil, *T.H. Nash 22283* (NY). CLEAR CREEK CO.: Summit Lake vicinity, 25.viii.2007, on humus, *W.A. Weber et al. L-95195* (COLO). GRAND CO.: Fraser Experimental Forest, 1.viii.1953, on humus, *W.A. Weber & E. Dahl s.n.* (COLO). JACKSON CO.: Park Range, W of Delaney Butte, 5.vii.2003, on soil, *R.C. Wittmann L-94449* (COLO). LARIMER CO.: Mummy Range, Fairchild Mt., 26.viii.1962, *R.A. Anderson 3583* (COLO). SAN JUAN CO.: trail from South Mineral Campground to Ice Lake Basin, 21.viii.1955, on soil, *W.A. Weber & J. Langenheim s.n.* (COLO). **IDAHO.** VALLEY CO.: 4 mi E of McCall, 5.ix.2008, on soil, *R. Rosentreter 16535* (NY). **MONTANA.** FLATHEAD CO.: Whitefish Range, 0.8 km SW of Standard Peak, 8.viii.1994, on soil, *T. Spribille 2287* (COLO). **OREGON.** WALLOWA CO.: Wallowa Mountains, Eagle Cap Wilderness, 7–9.ix.2005, on soil, *B. McCune 27983* (NY). **UTAH.** UINTAH CO.: Ashley National Forest, vicinity of Leidy Peak, 31.vii.2009, on humus, *W.R. Buck 55129B-831* (NY). **WYOMING.** PARK CO.: summit of Beartooth Mountains, 30.viii.1953, on soil, *P. Winston s.n.* (COLO).

Selected specimens examined [51 total seen from North America; psoromic chemotype, Chemotype 6]. – **CANADA. ONTARIO.** NIPISSING DIST.: Algonquin Park, 10.viii.2010, on rock, *I.M. Brodo 32719* (CANL). **U.S.A. CALIFORNIA.** SAN BERNARDINO CO.: Joshua Tree National Park, Wonderland of Rocks, 31.xii.2010, on rock, *K. Knudsen 13490* (NY, UCR). **COLORADO.** LARIMER CO.: near Horseshoe Park and road to Endovalley Campground, 23.vii.1962, on soil, *R.A. Anderson 2795* (COLO). **CONNECTICUT.** MIDDLESEX CO.: Town of Middletown, 10.vi.1961, on rock, *D. Wiley 27* (COLO). **MASSACHUSETTS.** WORCESTER CO.: Gardner, 12.x.1955, on bark, *V. Ahmadjian L97* (NY). **NEW YORK.** ORANGE CO.: Harriman State Park, 19.iv.1998, on *Fraxinus*, *R.C. Harris 42142*

(NY). **NORTH CAROLINA.** JACKSON CO.: Nantahala National Forest, Chattooga Wild and Scenic River/Elliott Rock Wilderness, 18.ix.2006, on rock, *J.C. Lendemer et al. 7881* (NY). **OREGON.** LAKE CO.: Glass Butte, 13.x.2009, on soil, *H. Root 1781b* (NY). **PENNSYLVANIA.** ELK CO.: State Game Lands No. 28, 9.ix.2010, on rock, *J.C. Lendemer 25110* (NY). VENANGO CO.: 1.5 mi N of Lisbon, 7.viii.1946, on rock, *H.N. Mozingo 602* (COLO). **UTAH.** UNITAH CO.: Ashley National Forest, along FS 104, 30.vii.2009, on soil in rock crevice, *W.R. Buck 55065* (NY). **OREGON.** LANE CO.: rocky summit of Fairview Mountain, 11.ix.1964, on rock, *W.A. Weber L-35245* (COLO). **WASHINGTON.** SKAGIT CO.: summit of Haystack Mt., ix.2008, on alpine soil, *B. McCune 28879* (NY, OSC).

Selected specimens examined [49 total seen from North America; stictic chemotype, Chemotype 7]. – **CANADA. BRITISH COLUMBIA:** Whistler Mountain, 22.viii.1994, on humus, *T. Ahti 52038* (H, NY). **U.S.A. CALIFORNIA.** MARIPOSA CO.: Yosemite National Park, S shore of Merced River, 20.ix.2009, on *Quercus*, *J.C. Lendemer 19632* (NY). TRINITY CO.: South Fork Summit, along forest road 0.2 mi N of CA 36, 25.vi.2002, on rock, *M.S. Cole 9987* (UCR). TUOLUMNE CO.: Yosemite National Park, Mammoth Peak Overlook, 21.ix.2009, on soil, *J.C. Lendemer 19691* (NY, zeorin present). **COLORADO.** GRAND CO.: near back of S slope Jackstraw Mountain, 4.vii.1962, on soil, *R.A. Anderson 2342* (COLO). **GEORGIA.** RABUN CO.: Tallulah Gorge State Park, 11.xi.2010, on rock, *S.Q. Beeching 10955* (NY). **IDAHO.** BUTTE CO.: Craters of the Moon National Monument, near Sentinel Butte, 4.vi.1964, on rock, *E.P. Menning 3* (COLO). **OREGON.** UMATILLA CO.: Pikes Peak, 21.x.2006, on *Grimmia*, *B. McCune 28484* (NY, OSC). **WASHINGTON.** PIERCE CO.: Mt. Rainier, 13.vii.1957, on ground, *W.J. Eyerdam 1834* (NY, SBBG). WHATCOM CO.: Mt. Baker National Forest, Tomyhoi Lake Trail, 4.viii.1967, on rock, *I.M. Brodo 13058 & M. Shchepanek* (COLO, MSC). **WYOMING.** PARK CO.: Beartooth Plateau, Cooke City to Red Lodge Highway, 20.viii.1973, on soil, *W.A. Weber L-57587* (COLO).

18) *Lepraria nivalis* J.R. Laundon, Lichenologist 24: 327. 1992. TYPE: **FRANCE:** Alpes-Maritimes, Nice, vieux chemin de Gairaut, vii.1945, sur les murs de soutènement et sur les talus, *M. Bouly de Lesdain s.n.* (MARSSJ [n.v.], holotype).

FIGURES 44 AND 45.

Description. – **Thallus** crustose, leprose, placodioid, without crisped margins, continuous and distinctly bi-layered, initially forming small discrete thalli which expand marginally, overlap, and become confluent to form a thick crust (0.2–0.4 mm thick), blue-white in color; **hyphae** hyaline, [1.4]–(1.9)–2.4–(3.0)–[4.2] µm (*n*=65), septate, secund, obscured by a layer of POL+ crystals that do not dissolve in KOH; **prothallus** disappearing with age; **hypothallus** a variably developed layer of densely intertwined hyphae surrounding and subtending the granules, sometimes outward from the edge of thallus; **rhizohyphae** uncommon, not pigmented; **granules** globose, [19]–(29)–43–(58)–[74] µm (*n*=65), ecorticate, well organized and discrete, rarely forming compound units, sometimes separating from the hypothallus and then producing abundant projecting hyphae; **photobiont** green, coccoid, cells globose, [6]–(6.8)–8.7–(10.6)–[13.2] µm (*n*=65).

Chemistry (of North American specimens examined). – Protocetraric acid, ± atranorin. Spot tests: K+ yellowish, C-, KC-, P+ orange-red, UV-.

Ecology and distribution. – In North America *Lepraria nivalis* appears to be restricted to the humid coastal regions of the Pacific Northwest with the excpetion of a disjunct population in coastal Central California (figure 45) that has now been extirpated by a wildfire. It occurs on the bark of hardwood trees as well as over bryophytes and rocks in sheltered situations. Populations have also been reported from coniferous substrates. However, no such vouchers were reviewed for this study.

Conservation status. – This taxon should be considered “data deficient” until more detailed studies are carried out in the Pacific Northwest to elucidate its range and abundance.

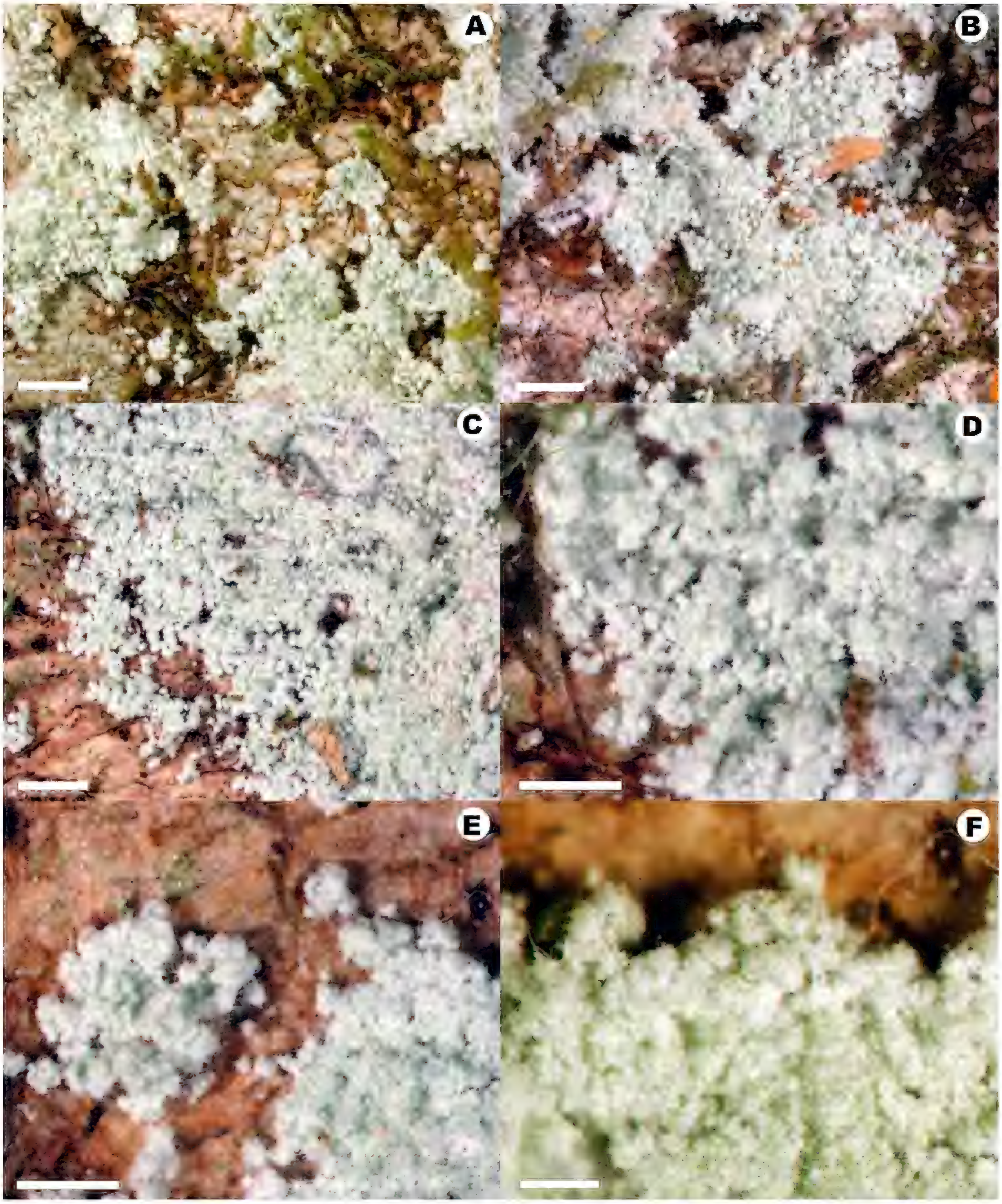

Figure 44, *Lepraria nivalis* (all from *Lendemer 22375*). A–C, macromorphology of the thallus (scales = 1.0 mm). D–E, detail of the thallus (scales = 0.5 mm). F, detail of the granules and thallus margin (scale = 0.25 mm).

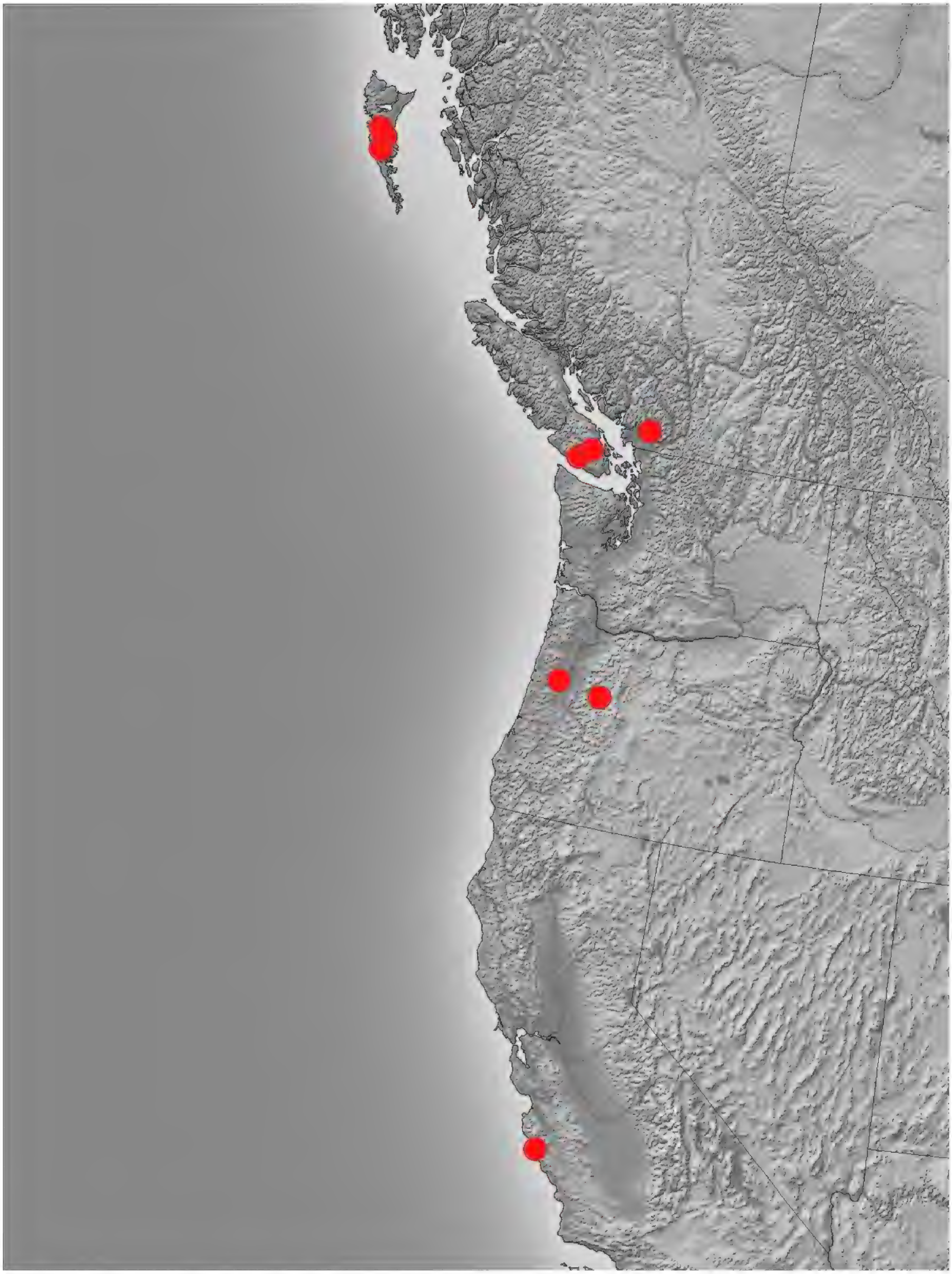

Figure 45, geographic distribution of *Lepraria nivalis* based on the specimens examined for this study.

Discussion. – As has been discussed by Lendemer and Harris (2007), *Lepraria nivalis* was broadly circumscribed by Laundon (1992) to include elements that were heterogeneous chemically, ecologically, and morphologically. Based on the protologue, and on reference material from Great Britain, *L. nivalis* should be restricted to material with a *finkii*-type thallus and lacking roccellic/angardianic acid. *Lepraria nivalis* was widely misapplied in eastern North America to the taxon that is now referred to as *L. normandinoides*. That species differs from *L. nivalis* in the production of roccellic/angardianic acid and in having a *normandinoides*-type placodioid thallus with crisped margins and dark rhizohyphae.

In North America only two species are likely to be morphologically confused with *Lepraria nivalis*, namely *L. finkii* and *L. torii*. Both species have *finkii*-type placodioid thallus but differ chemically from *L. nivalis* in producing atranorin, zeorin, and stictic acid (*L. finkii*) or roccellic/angardianic acid and fumarprotocetraric acid (*L. torii*). *Lepraria finkii* is not common in the Pacific Northwest, and thus is less likely to be confused with *L. nivalis* than *L. torii* is. *Lepraria torii* is ubiquitous in coastal forests of the Pacific Northwest (see the entry for that taxon for further discussion).

In the present study *Lepraria nivalis* is considered to be a rare species with a *finkii*-type placodioid thallus that produces protocetraric acid, often with accessory atranorin. The morphologically and ecologically identical sympatric populations that lack atranorin are tentatively retained in *L. nivalis* pending further study with molecular data. Additionally, it should be noted that no North American populations of *L. nivalis* producing fumarprotocetraric acid as the major substance were encountered for this study. Should such populations be found, they should also be included in a revision of the aforementioned populations that lack atranorin. Although the above chemical differences may seem minor, this is particularly salient considering the complex situation that the molecular phylogenetic analyses of the chemotypes of *L. normandinoides* have revealed (Lendemer 2012b). In that study, the fumarprotocetraric acid and protocetraric acid chemotypes were found to represent well supported monophyletic entities, worthy of recognition as distinct species, while the depside deficient chemotype was found to represent a reversion within the protocetraric acid chemotype.

It should also be noted that the present delineation of *Lepraria nivalis* still requires confirmation with molecular data despite the fact that sequences have been included in molecular phylogenetic analyses for multiple published studies (Ekman & Tønsberg 2002; Lendemer 2012b; Tretiach et al. 2009). This is due to the fact that there are neither molecular data available for the populations of *L. nivalis* from the type region (France) nor for the chemotype represented by the type (atranorin and fumarprotocetraric acid). The original nuITS sequence (GenBank accession #AF517895) generated for this taxon by Ekman and Tønsberg (2002) is derived from a voucher[4] collected in Alaska that produces atranorin and protocetraric acid (T. Tønsberg pers. comm.). This sequence has been assumed to be representative of *L. nivalis* s.str. and thus used for reference in subsequent studies (Lendemer 2012b; Tretiach et al. 2009). Both of these subsequent studies recovered a sequence (GenBank accession #FJ184309) derived from a voucher from Europe (Solvenia) in a strongly supported clade with the original sequence generated from the Alaskan population.

Specimens examined (8 total seen from North America; the presence of atranorin is indicated by "at+"). – **CANADA. BRITISH COLUMBIA.** QUEEN CHARLOTTE ISLANDS: Maude Island, in Skidegate Inlet, 12.vii.1967, on shaded mossy bank, *I.M. Brodo 11268 & M.J. Shchepanek* (NY, at+). CAPITAL REGIONAL DIST.: Vancouver Island, Lizard Lake Loop, Lizard Lake, 25.v.2010, on *Alnus*, *J.C. Lendemer 22375 & A. Moroz* (NY). DEWDNEY-ALOUETTE DIST.: Golden Ears Provincial Park, along Lower Falls Trail from parking area, 10.v.2009, on *Populus*, *W.R. Buck 54713* (NY). **U.S.A. CALIFORNIA.** MONTEREY CO.: Santa Lucia Mountains, Lime Kiln State Park, 11.ix.2008, on rock, *K. Knudsen 10261* ((NY). **OREGON.** BENTON CO.: Pilomath, iv.1932, on mossy tree trunk, *F.P. Sipe 691* (COLO, at+). **WASHINGTON.** SNOHOMISH CO.: near Skyhomish, 2.vi.1937, on Douglas fir, *W.J. Eyerdam 1826* (NY, SBBG, at+).

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[4] Voucher data for GenBank AF517895 – **U.S.A. ALASKA:** City and Borough of Sitka, Baranof Island SW, E of NE tip of Redoubt Lake, S of inlet stream, 56°55.251'N, 135°07.555'W, 10–15 m, 11.ix.1999, corticolous on trunk of *Chamaecyparis nootkatensis* in a muskeg, *T. Tønsberg 27804* (NY). – TLC (performed by Tønsberg): atranorin, protocetraric acid.

19) ***Lepraria normandinoides*** **Lendemer & R.C. Harris,** Opuscula Philolichenum 4: 45. 2007. TYPE: **U.S.A. NORTH CAROLINA.** TRANSYLVANIA CO.: Nantahala National Forest, Shower Falls, along Cold Mountain Road, south slope of Panthertail Mountain, Lake Toxaway Quad., 3500 ft., small roadside waterfall over gneiss, 29.v.2006, on gneiss in overhang, *J.C. Lendemer et al. 7001 = Lich. East. N. Amer. Exs. V: 221* (NY!, holotype; ASU!, B!, BG!, CANB!, FH!, GZU!, H!, M!, MIN!, S!, TNS!, TU!, isotypes).

FIGURES 46 AND 47.

Description. – **Thallus** crustose, leprose, placodioid with crisped margins, continuous and distinctly bi-layered, initially forming small discrete thalli which expand marginally, overlap, and become confluent to form a thick crust (0.2–0.5 mm thick), bone white to light blue-white; **hyphae** hyaline or pigmented, [1.8]–(2.3)–2.9–(3.7)–[4.8] µm (*n*=58), septate, secund, obscured by a layer of POL+ crystals that do not dissolve in KOH; **prothallus** disappearing with age; **hypothallus** a variably developed layer of loosely intertwined hyphae surrounding and subtending the granules, extending outward from the edge of thallus; **rhizohyphae** present, typically abundant, pigmented brown; **granules** globose, [19]–(24)–38–(53)–[84] µm (*n*=52), ecorticate, well organized and discrete, not forming compound units, sometimes separating from the hypothallus and then producing abundant projecting hyphae; **photobiont** green, coccoid, cells globose, [6]–(7.9)–9.8–(11.6)–[13.2] µm (*n*=72).

Chemistry. – Atranorin, roccellic/angardianic acid, ± protocetraric acid. Spot tests: K+ yellow, C-, KC-, P+/- orange/red, UV-.

Ecology and distribution. – *Lepraria normandinoides* is a North American endemic that is widely distributed throughout temperate eastern North America with rare disjunct populations extending westward into the greater Sonoran Desert region and the Black Hills of South Dakota (figure 47). The species occurs in high humidity low-light habitats on sheltered non-calcareous rock faces and overhangs as well as the bark of hardwoods and conifers. Acid deficient populations of *L. normandinoides* are rare and so far known only from the northern/boreal portions of its geographic range.

Conservation status. – *Lepraria normandinoides* is a North American endemic that is common throughout its core range as outlined above. This species does not likely represent a conservation priority.

Discussion. – *Lepraria normandinoides* is a common and conspicuous species that is widespread in eastern North America. Due to its appearance, as well as the thickness of the thallus which facilitates easy collection with minimal substrate, the species is somewhat less impacted by collector bias when compared to other sympatric species with less conspicuous thalli. Historically the species was confused with *L. lobificans* auct. (i.e., *L. finkii*) until Laundon (1989) restricted the use of that name to material producing atranorin and stictic acids. Laundon (1989) then described material with atranorin and protocetraric or fumarprotocetraric acids that has been referred to *L. lobificans* as a new taxon, *L. nivalis*. *Lepraria normandinoides* was included within Laundon's broad concept of *L. nivalis* until Lendemer and Harris (2007) recognized it was chemically, ecologically, and morphologically distinct.

In the field the only species likely to be confused with *Lepraria normandinoides* is *L. oxybapha*, which was previously included within a broad circumscription of that species (Lendemer 2012b). Molecular phylogenetic analyses, however, showed that the populations of *L. normandinoides* that produce fumarprotocetraric acid form a strongly supported monophyletic group sister to *L. normandinoides* s. str. As such *L. normandinoides* was restricted to only the populations that produce protocetraric acid or are acid deficient.

Other species of *Lepraria* with placodioid thalli might be confused with *L. normandinoides* are *L. eburnea*, *L. finkii*, *L. nivalis*, *L. torii*, and *L. vouauxii*. However, none of those species have thalli that develop a marginal lip and all have different chemical profiles (atranorin, zeorin, stictic acid aggregate in *L. finkii*; protocetraric acid with or without atranorin in *L. nivalis*; roccellic/angardianic acid and fumarprotocetraric acid in *L. torii*; and dibenzofurans of the pannaric acid aggregate in *L. vouauxii*). *Lepraria lanata*, a species endemic to the high elevations of the southern Appalachians, is chemically similar to *L. normandinoides* but differs markedly in having massive granules (>100 µm in diameter) which resemble small cotton balls.

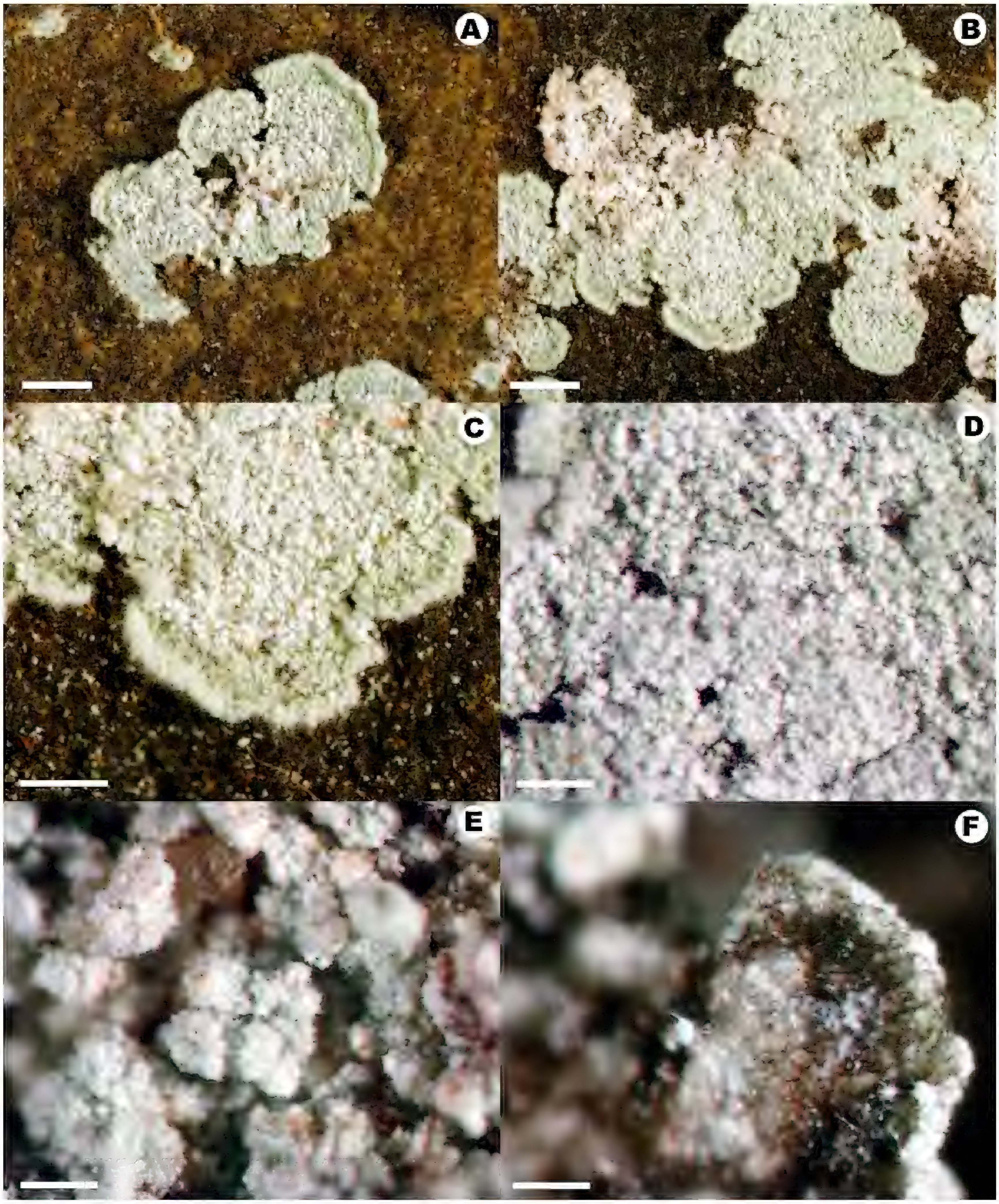

Figure 46, *Lepraria normandinoides* (all from *Hollinger 2229* unless otherwise indicated). A–B, gross morphology of the thallus (scales = 1.0 mm). C, detail of the thallus margin (scale = 0.5 mm). D, detail of the thallus surface (scale = 0.25 mm). E, aggregation of granules becoming separated from the hypothallus (*Lendemer 25913*, scale = 0.25 mm). F, dark pigmented hyphae extending from the lower surface of the thallus (*Lendemer 26222*, scale = 0.25 mm).

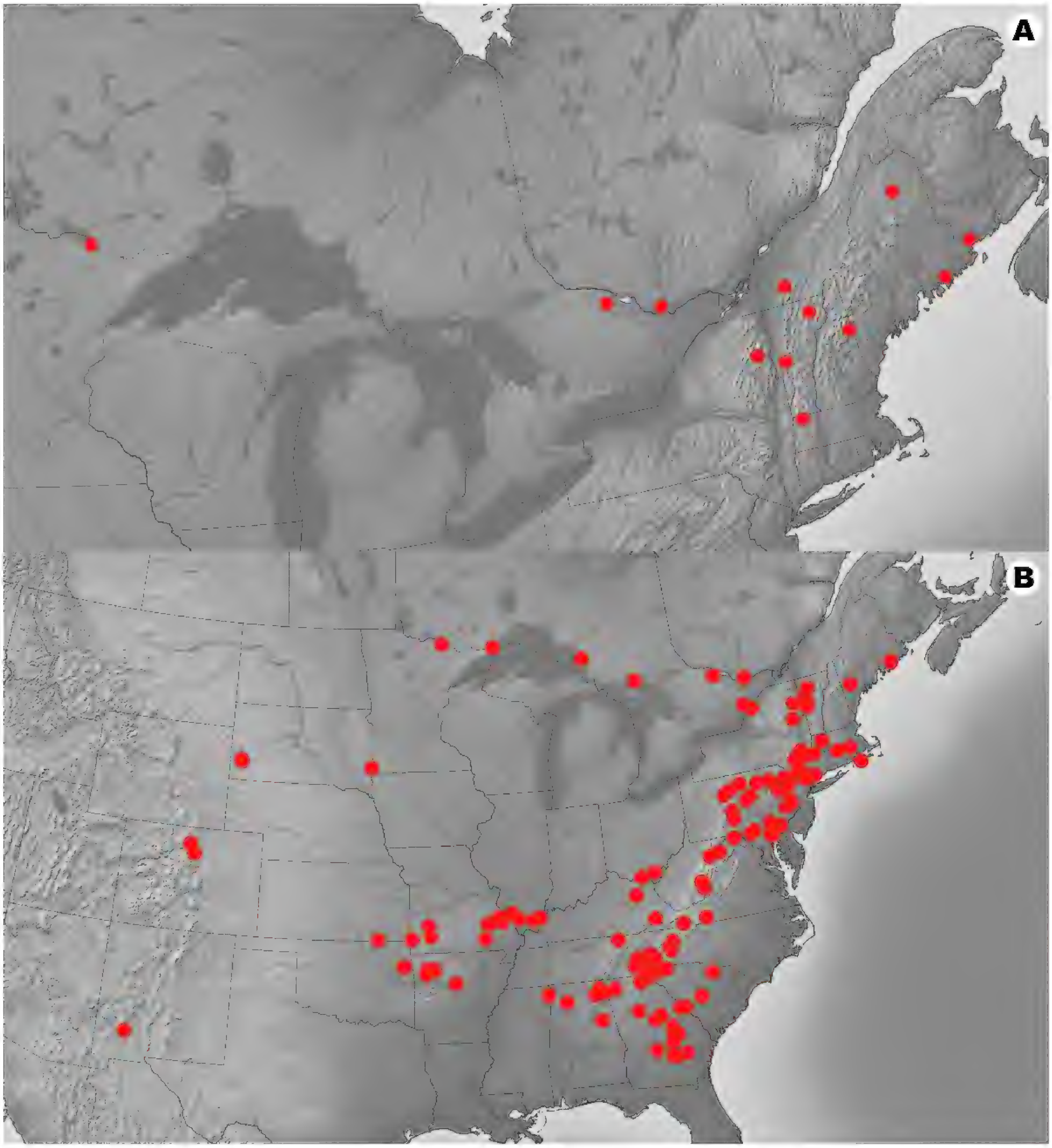

Figure 47, geographic distribution of *Lepraria normandinoides* based on the specimens examined for this study. A, acid deficient chemotype. B, protocetraric acid chemotype.

Selected specimens examined (243 total seen from North America; "*" denotes depside deficient collections). – **CANADA. ONTARIO.** ALGOMA DIST.: Lake Superior Provincial Park, Agawa Rock Pictographs trail, 14.vii.2011, on rock, *I.M. Brodo 32945 & F. Brodo* (CANL). LEEDS CO.: Lake Opinicon, Snake Island, 5.ii.1983, on mosses, *S. Selva 303-A* (UMFK). **U.S.A. ALABAMA.** CLAY CO.: Talladega National Forest, Chinnabee Silent Trail, 24.ix.1992, on rock, *R.C. Harris 28390* (NY). DeKALB CO.: DeSoto State Park, 4.x.1998, on rock, *W.R. Buck 34741* (NY). JACKSON CO.: Buck's Pocket State Park, 3.x.1998, on rock, *R.C. Harris 42378* (NY). **ARKANSAS.** FRANKLIN CO.: Ozark National Forest, Ozark Highlands National Recreational Trail, 8.vi.2000, on rock, *W.R. Buck 37275* (NY). NEWTON CO.: Ozark National Forest, E of FSR 1463, 28.iii.2006, on sandstone, *J.C. Lendemer et al. 6557* (NY, PH).

CONNECTICUT. WINDHAM CO.: Town of Ashford, Yale Forest, along Boston Hollow Rd. ~0.6 mi NE of jct w/ Eastford Rd., 24.vii.2002, on rock, *R.C. Harris 46097* (NY). **COLORADO.** BOULDER CO.: Boulder Canyon, 10.vii.1963, on rock, *R.A. Anderson 3979* (COLO). LARIMER CO.: Scilly Gulch, 7 mi E of Estes Park, 8.iv.1952, on rock, *M.L. Mattoon S-524* (COLO). **GEORGIA.** COFFEE CO.: Broxton Rocks Ecological Preserve, 9.ii.2003, on *Magnolia*, *R.C. Harris 47050* (NY). COLUMBIA CO.: Heggie's Rock TNC Preserve, 8.xi.2008, on rock, *G.B. Perlmutter et al. 1639* (NY). RABUN CO.: Lake Burton Wildlife Management Area, 17.ix.2006, on rock, *J.C. Lendemer et al. 7657* (NY). ROCKDALE CO.: Panola Mountain State Park, 17.iv.2007, on granite, *J.C. Lendemer et al. 8984* (NY). **ILLINOIS.** POPE CO.: Shawnee National Forest, Burden Falls, 26.v.1997, on rock, *L.R. Phillippe 28777* (NY). RANDOLPH CO.: Piney Creek Ravine Nature Preserve, 7.xi.2004, on sandstone, *R.C. Harris 50566* (NY). **KANSAS.** CHAUTAUQUA CO.: 0.5 mi E, 0.25 mi S of Chautauqua, private land along Turkey Creek to Devil's Canyon, 21.ii.2003, on *Quercus*, *M.K. Advaita 2142* (KANU). **KENTUCKY.** BATH CO.: Daniel Boone National Forest, Tater Knob, 10.x.1995, on *Nyssa*, *R.C. Harris 36882* (NY). LETCHER CO.: Bad Branch Nature Preserve, 14.ix.1991, on rock, *R.C. Harris 27023* (NY). **MAINE.** AROOSTOOK CO.: T10 R8 WELS and T11 R8 WELS, near summit of Jack Mountain, 16.v.1985, on rock, *S. Selva 1609A & T. Talarico* (UMFK*). HANCOCK CO.: T10SD, slope of Tunk Mountain, 8.vii.2008, on rock, *R.C. Harris 54743* (NY); T10SD, Maine Public Reserve Lands, 0–0.25 mi N of ME82 directly across from Tunk Lake Access, 10.vi.2010, on rock, *J.C. Lendemer 23028* (NY*); Little Deer Isle, 8.xi.2005, on rock, *T. Harris 194* (NY*). OXFORD CO.: Berry Ledge, Paris, 29.ix.1931, on rock, *J.C. Parlin 9897* (NY). WASHINGTON CO.: T10SD, Donnell Pond Public Reserve Lands, Black Mountain, 10.vi.2010, on *Betula*, *J.C. Lendemer 29957* (NY). **MARYLAND.** CECIL CO.: New Valley, along Basin Run, 1.xii.2009, on rock, *J.C. Lendemer 20017* (NY). BALTIMORE CO.: Gunpowder Falls, 18.ix.1909, on rock, *C.C. Plitt 328* (FH, NY [FH specimen marked "at Harford Rd. Bridge and not Gunpowder Falls"]). WASHINGTON CO.: Sideling Creek, 4.vi.1990, on rock, *C.F. Reed 136003-A* (NY). **MASSACHUSETTS.** BERKSHIRE CO.: Bartholomew's Cobble, 28.iii.1981, on rock, *R.C. Harris 13540* (NY). SUFFOLK CO.: Williams Pond, Jamaica Plain, 26.x.1883, on rock, *E. Faxon s.n.* (FH). **MINNESOTA.** ST. LOUIS CO.: Voyageurs National Park, E side of Browns Bay, 13.vii.1979, on rock, *C.M. Wetmore 39989* (NY*). **MISSISSIPPI.** TISHOMINGO CO.: Tishomingo State Park, 27.ix.1992, on rock, *R.C. Harris 28584* (NY). **MISSOURI.** IRON CO.: E slope of Royal Gorge, 27.iv.1988, on rock, *R.C. Harris 21781* (NY). MADISON CO.: Amidon Memorial Conservation Area, 21.x.2001, on rock, *R.C. Harris 45058* (NY). NEWTON CO.: Wildcat Glade Natural Area, 6.xi.2002, on rock, *W.R. Buck 42997* (NY). **NEW HAMPSHIRE.** COOS CO.: White Mountains National Forest, Mountain Pond Research Area, 20.v.1992, on *Fagus*, *S. Selva 4902A & P. Edberg* (UMFK*). **NEW JERSEY.** BERGEN CO.: Palisades, *sine date*, on rock, *C.F. Austin s.n.* (NY). MORRIS CO.: Ledgewood, 10.viii.1914, on rock, *C. Barbour 3* (NY). **NEW MEXICO.** SIERRA CO.: Black Range, along North Percha Creek, 8.vii.1995, on rock, *R.D. Worthington 25042* (COLO, NY, UTEP). **NEW YORK.** ESSEX CO.: Town of Keene, Chapel Pond, 19.ix.2004, on rock, *R.C. Harris 50039* (NY). JEFFERSON CO.: Wellesley Island State Park, 20.ix.1983, on mosses over rock, *R.C. Harris 16746* (NY). ROCKLAND CO.: Bear Mountain State Park, Iona Island Bird Sanctuary, 18.vii.2010, on rock, *J.C. Lendemer 23681 & A. Moroz* (NY). ULSTER CO.: Ice Caves Mountain National Landmark, 14.v.1994, on rock, *R.C. Harris 32840* (NY). WESTCHESTER CO.: Croton Dam Rd., 0.5 mi S of NY129, 27.vii.1975, on *Carya*, *C.R. Prince 75-65* (NY). **NORTH CAROLINA.** CLAY CO.: Nantahala National Forest, Southern Nantahala Wilderness, 17.ix.2006, on *Acer*, *J.C. Lendemer et al. 7736* (NY). JACKSON CO.: Bad Creek Trail to Ellicott's Rock, 28.ix.1989, on *Quercus*, *R.C. Harris 24866* (NY). MACON CO.: Nantahala National Forest, McDowell Mt., 12.viii.1994, on rock, *R.C. Harris 33149* (NY). SWAIN CO.: Great Smoky Mountains National Park, Straight Fork Rd., 6.viii.2009, on rock, *J.C. Lendemer 19159 & E.A. Tripp* (NY). TRANSYLVANIA CO.: Gorges State Park, 9.viii.2005, on *Quercus*, *J.C. Lendemer 4586 & E.A. Tripp* (NY). YANCEY CO.: NE slope of Mt. Mitchell and Commissary Ridge in Black Mountains, along Maple Camp Ridge trail, 1972, on rock, *J.P. Dey 1367* (NY). **OHIO.** GALLIA CO.: Wayne National Forest, above Symmes Creek, 19.v.2006, on sandstone, *J.C. Lendemer et al. 7437* (NY). SCIOTO CO.: Shawnee State Forest, along Pond Lick Run, 21.v.2005, on sandstone, *J.C. Lendemer 7161* (NY). **OKLAHOMA.** CHEROKEE CO.: J.T. Nickel Family Nature and Wildlife Preserve, 30.x.2000, on rock, *W.R. Buck 38448* (NY). LOVE CO.: Lake Murray State Park, 24.iv.2004, on sandstone, *S. Strawn & S. Strawn 92* (NY). **PENNSYLVANIA.** CARBON CO.: Hickory Run State Park, 19.v.2009, on rock, *J.C. Lendemer 17573 & R.C. Harris* (NY). HUNTINGDON CO.: Trough Creek State Park, 22.iv.2008, on rock, *W.R. Buck 53550* (NY). MONROE CO.: Tannersville Bog TNC Preserve, 24.xi.2009, on rock, *J.C. Lendemer 19552 & V. Doyle* (NY). TIOGA CO.: Tioga State Forest, E shore of Gleason Hollow Run, 14.v.2009, on rock, *J.C. Lendemer 16925* (NY). WYOMING CO.: Bowmans Creek Ledges, 20.vii.2008, on rock, *J.C. Lendemer 13510* (NY). YORK CO.: Apollo County Park, 9.viii.2009, on rock, *J.C. Lendemer 19455* (NY). **RHODE ISLAND.** PROVIDENCE CO.: Town of Lincoln, Lime Rock Nature Preserve, 17.ix.2006, on rock, *R.C. Harris 53210* (NY). **SOUTH CAROLINA.** GREENVILLE CO.: Caesars Head State Park, 14.iii.1997, on base of tree, *R.C. Harris 40035* (NY). **SOUTH DAKOTA.** MINNEHAHA CO.: Palisades State Park, 10.v.2004, on quartzite, *M.K. Advaita 3491* (NY). **TENNESSEE.** BLOUNT CO.: Great Smoky Mountains National Park, Rich Mountain Gap, 30.vi.2010, on *Quercus*, *J.C. Lendemer et al. 23584* (NY). COCKE CO.: Great Smoky Mountains National Park, Gabes Mountain Trail, 5.viii.2009, on *Quercus*, *J.C. Lendemer 19078 & E.A. Tripp* (NY). MONROE CO.: Cherokee National Forest, Citico Creek Wilderness, 6.viii.1994, on *Acer*, *R.C. Harris 32915* (NY). SCOTT CO.: Big South Fork National River and Recreation Area, 7.viii.1994, on rock, *R.C. Harris 32967* (NY). **VERMONT.** ADDISON CO.: Green Mountain National Forest, Chandler Ridger Candidate Research Natural Area, 2.vi.1993, on *Acer*, *S. Selva 5503A & P. Edberg* (UMFK), on *Fagus*, *S. Selva 5513A & P. Edberg* (UMFK*). LAMOILLE CO.: Smugglers Notch, 21.vi.1922, on rock, *D.L. Dutton 1666* (FH). **VIRGINIA.** GRAYSON CO.: Jefferson National Forest, Comers Creek, 5.iv.2008, on hardwood, *G.B. Perlmutter 1291* (NY). PATRICK CO.: Blue Ridge Parkway, Rock Castle Gorge Loop Trail, 6.x.1995, on rock, *R.C. Harris 36656* (NY). **WEST VIRGINIA.** POCAHONTAS CO.: Monongahela National Forest, upper slopes of Spruce Mountain, 20.x.2007, on *Acer*, *J.C. Lendemer 9936 & A. Moroz* (NY). WYOMING CO.: near New Richmond, 30.v.1967, on rock, *C.F. Reed 74818* (NY).

20) ***Lepraria oxybapha*** **Lendemer,** J. Torrey Bot. Soc. 139: 127. 2012. TYPE: **U.S.A. PENNSYLVANIA.** SULLIVAN CO.: Ricketts Glen State Park, S slopes above Big Run, 1 mi W of jct w/ PA 487, 2067 ft., *Tsuga/Betula/Acer* forest with cold air talus slope and large sheer cliffs, 19.ix.2010, on rock in overhang, *J.C. Lendemer 25637 & J. Kunsman* (NY!, holotype).

FIGURES 48 AND 49.

Description. – **Thallus** crustose, leprose, placodioid with crisped margins, continuous and distinctly bi-layered, initially forming small discrete thalli which expand marginally, overlap, and become confluent to form a thick crust (0.2–0.5 mm thick), bone white to light blue-white in color; **hyphae** hyaline or pigmented, [2.1]–(2.6)–3.3–(4.0)–[4.8] µm (*n*=39), septate, secund, obscured by a layer of POL+ crystals that do not dissolve in KOH; **prothallus** disappearing with age; **hypothallus** a variably developed layer of loosely intertwined hyphae surrounding and subtending the granules, extending outward from the edge of thallus; **rhizohyphae** present, typically abundant, pigmented brown; **granules** globose, [24]–(35)–48–(61)–[80] µm (*n*=45), ecorticate, well organized and discrete, not forming compound units, sometimes separating from the hypothallus and then producing abundant projecting hyphae; **photobiont** green, coccoid, cells globose, [5]–(7.7)–9.6–(11.5)–[13.2] µm (*n*=39).

Chemistry. – Atranorin, roccellic/angardianic acid, fumarprotocetraric acid, and traces of protocetraric acid. Spot tests: K+ yellow, C-, KC-, P+ orange/red, UV-.

Ecology and distribution. – *Lepraria oxybapha* is a North American endemic whose range primarily correlates to an Appalachian-Ozarks distribution (Brodo et al. 2001; figure 49 herein). Although it is widespread throughout those regions it is most frequent in the northern/central Appalachians, becoming rarer further south and in the Ozarks. Rare disjunct populations occur westward in the Great Plains and the Greater Sonoran Desert Region. The species is restricted to high humidity low-light habitats where it occurs on the bark of conifers and hardwoods as well as sheltered non-calcareous rock faces and overhangs.

Conservation status. – This species is a North American endemic that is common in its core range, as outlined in the preceding section. The taxon does not likely require conservation measures at present.

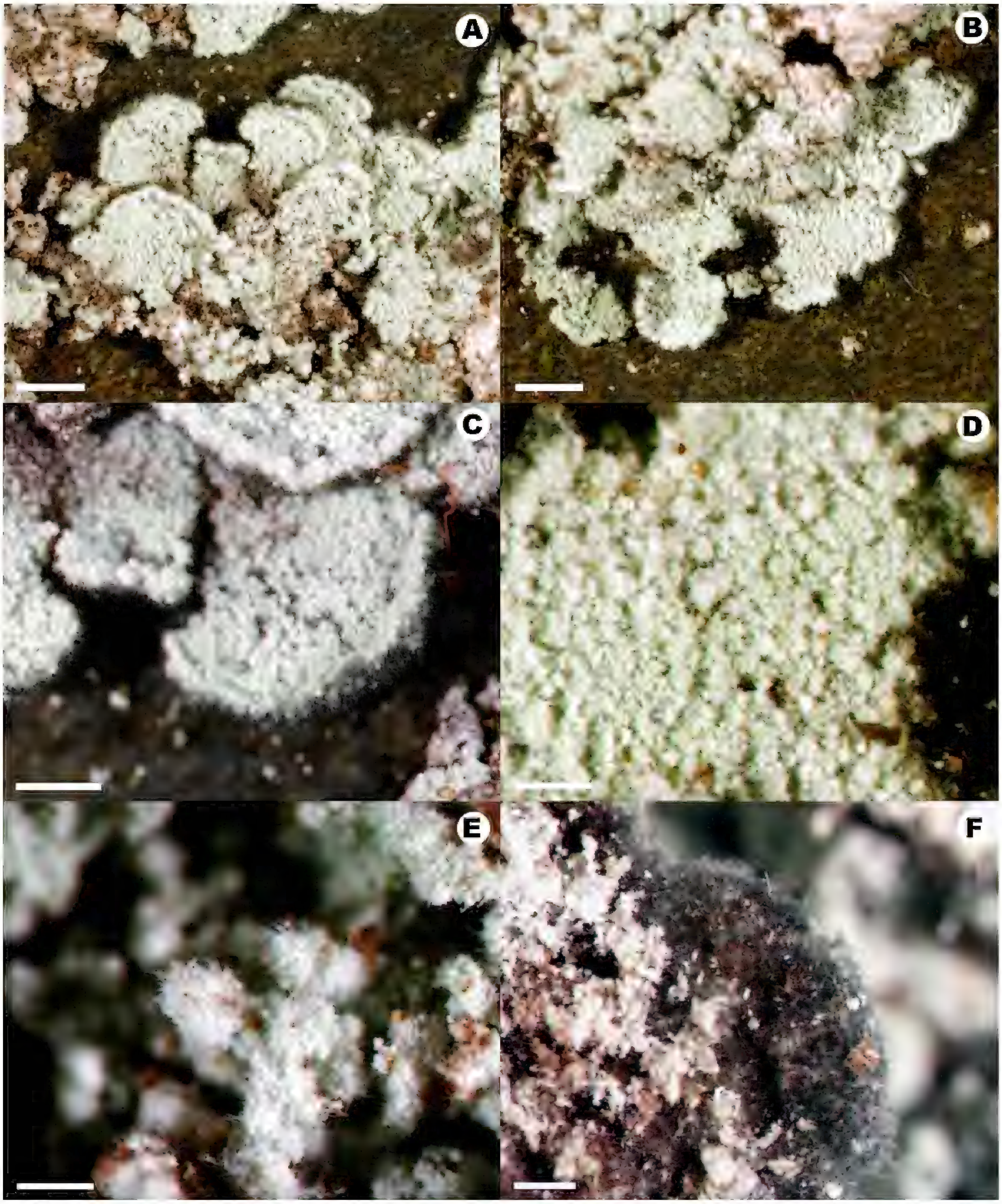

Figure 48, *Lepraria oxybapha* (all from *Lendemer 29526*). A–B, gross morphology of the thallus (scales = 1.0 mm). C, detail of the thallus margin (scale = 0.5 mm). D, detail of the thallus surface (scale = 0.25 mm). E, aggregation of granules becoming separated from the hypothallus (scale = 0.25 mm). F, dark pigmented rhizohyphae extending from the lower surface of the thallus (scale = 0.25 mm).

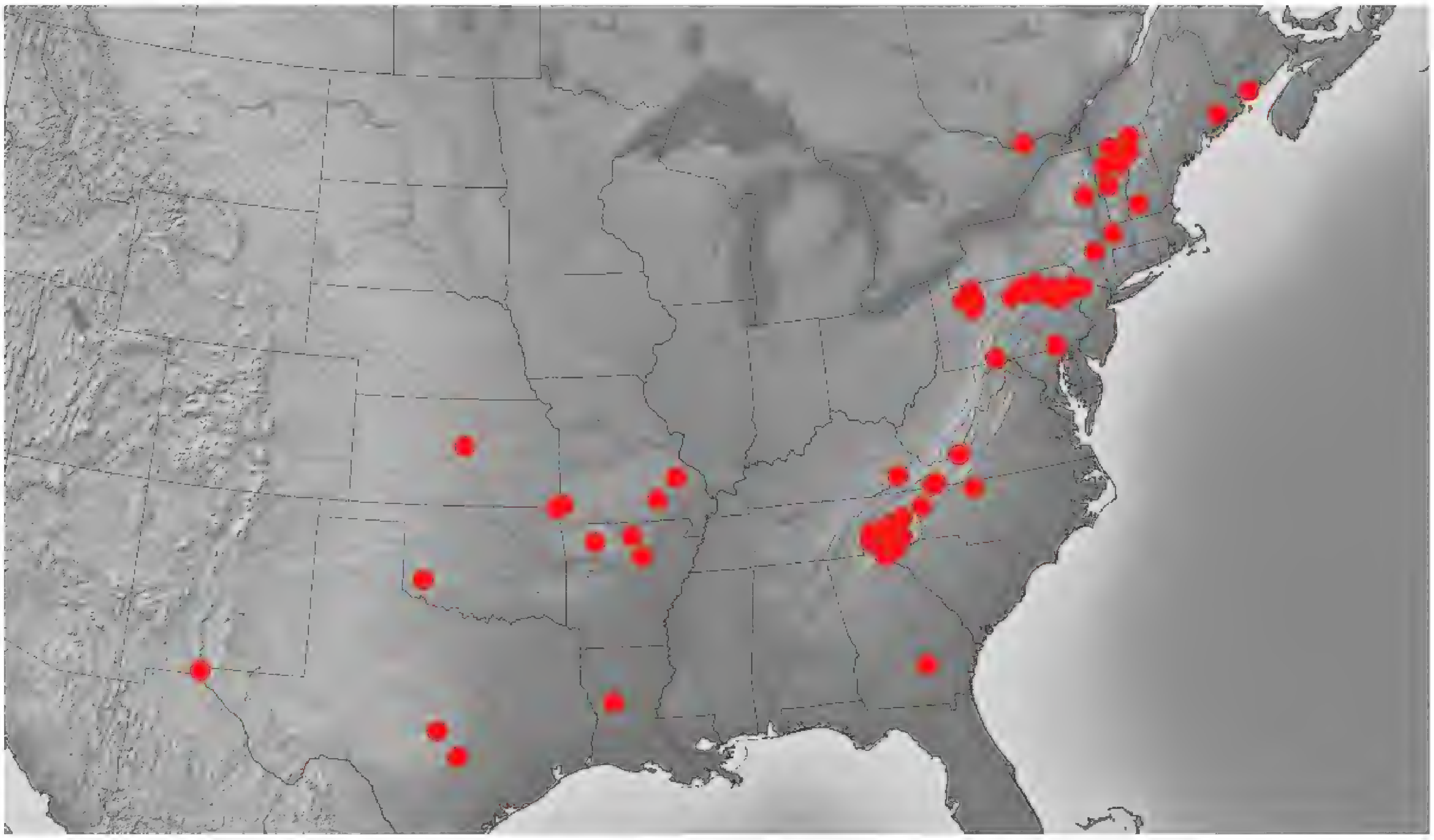

Figure 49, geographic distribution of *Lepraria oxybapha* based on the specimens examined for this study.

Discussion. – *Lepraria oxybapha* is a distinctive North American species that can be recognized by its thalli, which develop a marginal lip, brown rhizohyphae on the lower surface, occurrence on trees and non-calcareous substrates, and the presence of fumarprotocetraric acid in addition to atranorin and roccellic/angardianic acid. *Lepraria normandinoides* is morphologically identical but differs chemically in the presence or absence of protocetraric acid instead of fumarprotocetraric acid as a major substance. *Lepraria torii*, a species whose distribution is primarily bi-coastal in boreal North America, with occasional disjunct occurrences throughout the boreal forests, also produces roccellic/angardianic acid and fumarprotocetraric acids and thus could be confused with *L. oxybapha*. That species is rarely sympatric with *L. oxybapha*, typically does not produce atranorin, and has a distinctive green thallus that lacks a marginal lip.

Selected specimens examined (110 total seen from North America). – **U.S.A. ARKANSAS.** STONE CO.: Ozark National Forest, City Rock Bluff Special Interest Area, 18.iv.2005, on sandstone, *R.C. Harris 51247* (NY). **GEORGIA.** COFFEE CO.: Broxton Rocks Ecological Preserve, 16–17.xii.1993, on rock, *R.C. Harris 32693* (NY). TOWNS CO.: Southern Nantahala Wilderness, Chattahoochee National Forest, Hightower Gap to Rich Knob, 11.xi.2007, on rock, *J.C. Lendemer et al. 10935* (NY). **KANSAS.** ELLSWORTH CO.: 2.25 mi S, 10.5 mi E of Kanopolis, Kanopolis Reservoir, 12.x.2003, on soil, *T. Hildebrand & D. Hildebrand s.n.* (KANU). **KENTUCKY.** LETCHER CO.: Bad Branch Nature Preserve, 14.ix.1991, on rock, *R.C. Harris 27016* (NY). **LOUISIANA.** NATCHITOCHES PARISH: Kisatchie National Forest, Longleaf Trail Vista, 27.iii.1982, on sandstone, *J. Pruski 2472* (NY). **MAINE.** HANCOCK CO.: T28MD, SE slopes of Lead Mountain, 11.vi.2010, on *Fagus*, *J.C. Lendemer 23199* (NY). **MASSACHUSETTS.** BERKSHIRE CO.: Town of Pittsfield, Pittsfield State Forest, 4.vi.2010, on *Betula*, *J.C. Lendemer 22459* (NY). **MISSOURI.** SHANNON CO.: Ozark National Scenic Riverways, Rocky Falls, 22.ix.1990, on rock, *R.C. Harris 25576* (NY). **NEW HAMPSHIRE.** CHESHIRE CO.: Charles Pierce Wildlife Reservation, Lightning Hill, 16.x.1999, on *Acer*, *S. Selva 8349A & P. Edberg* (UMFK). **NEW YORK.** GREENE CO.: Town of Hunter, Stony Clove Notch, 13.ix.2008, on *Betula*, *J.C. Lendemer 14083-A* (NY). ULSTER CO.: Town of Shandaken, Slide Mountain Wilderness Area, 13.ix.2008, on *Betula*, *J.C. Lendemer 14011* (NY). **NORTH CAROLINA.** CLAY CO.: Nantahala National Forest, Buck Creek, 10.xi.2007, on *Betula*, *J.C. Lendemer et al. 10453* (NY). HAYWOOD CO.: Great Smoky Mountain National Park, around Caldwell Fork, 4.viii.2009, on dead tree, *E.A. Tripp 631 & J.C. Lendemer* (NY). MADISON CO.: 3 mi S of Hot Springs, 27.viii.1968, on rock, *W.L. Culberson 14276*

(NY). **OKLAHOMA.** GREER CO.: Quartz Mountain Arts & Conference Center and Nature Park, 10.iv.2007, on moss over rock, *C.A. Morse 15061 & D. Ladd* (KANU, NY). OTTAWA CO.: N of E0060 Rd. on W side of Spring River, 31.x.2000, on rock, *R.C. Harris 44436* (NY). **PENNSYLVANIA.** BRADFORD CO.: State Game Lands No. 36, 18.v.2009, on *Betula*, *J.C. Lendemer 17349 & R.C. Harris* (NY). MONROE CO.: Tobyhanna State Park, 27.vii.2009, on *Acer*, *J.C. Lendemer 18627* (NY). TIOGA CO.: Tioga State Forest, slopes above jct US 15/I-99, 12.v.2009, on rock, *J.C. Lendemer 16495 & D. Atha* (NY). WAYNE CO.: Lacawac Sanctuary, 25.vii.2009, on *Betula*, *J.C. Lendemer 18451* (NY). WYOMING CO.: State Game Lands No. 57, Henry Lott Rd., 21.vii.2008, on rock, *J.C. Lendemer 13626* (NY). YORK CO.: W-shore of Susquehanna River, 0.5 mi S of jct River Rd. & PA 372, 28.v.2009, on *Betula*, *J.C. Lendemer 17978* (NY). **TENNESSEE.** BLOUNT CO.: Great Smoky Mountains National Park, Gabes Mountain Trail, 5.viii.2009, on rock, *J.C. Lendemer 19059 & E.A. Tripp* (NY). SEVIER CO.: Great Smoky Mountains National Park, Chimney Tops Trail, 28.vi.2010, on *Liriodendron*, *R.C. Harris 56182* (NY). **TEXAS.** LLANO CO.: sine loc., 30.i.1931, on granite, *E. Whitehouse 48* (NY). **VERMONT.** ESSEX CO.: Town of Victory, Victory State Forest, Umpire Mountain, 16.v.2008, on rock, *R.C. Harris 54350* (NY). ORLEANS CO.: Town of Westfield, Green Mountains, Hazen's Notch, 13.v.2005, on rock, *R.C. Harris 51347* (NY). RUTLAND CO.: The Cape Research Natural Area, E slope of Lookoff Mt., 10.vi.1992, on *Betula*, *S. Selva 5046A & P. Edberg* (UMFK). WASHINGTON CO.: Groton State Forest, Lord's Hill Natural Area, 11.vi.1992, on *Betula*, *S. Selva 5106A & P. Edberg* (UMFK). **VIRGINIA.** GILES CO.: Mountain Lake Biological Station, 7.x.1995, on *Betula*, *R.C. Harris 36718* (NY). SMYTH CO.: Jefferson National Forest, Whitetop Mountain, 5.iv.2008, on *Sorbus*, *R.C. Harris 54112* (NY).

21) *Lepraria pacifica* Lendemer, Mycologia 103: 1226. 2011. TYPE: **U.S.A. CALIFORNIA.** MARIPOSA CO.: Yosemite National Park, S side of Merced River, downstream of Phono Bridge, W end of Yosemite Valley, 1172 m, mesic north-facing talus slope, with mixed conifer forest, on *Calocedrus*, 22 Sept 2009, *J.C. Lendemer 19765* (NY!, holotype).

FIGURES 50 AND 51.

Description. – **Thallus** crustose, leprose, aggregated, discontinuous and not stratified to continuous and weakly stratified, initially composed of isolated granules that divide to form aggregations, eventually merging to form a crust of variable thickness (0.1–0.4(–0.7) mm), greenish-blue in color; **hyphae** hyaline, [1.7]–(2.2)–2.8–(3.3)–[4] µm (*n*=120) in width, septate, secund, obscured by a thick layer of crystals that dissolve in KOH; **prothallus** persistent and readily visible; **hypothallus** typically indistinct, poorly developed or absent; **rhizohyphae** absent; **granules** globose, [16]–(24)–32–(40)–[60] µm (*n*=120) in diameter, ecorticate initially and eventually forming a poorly developed pseudocortex, well organized and discrete; **photobiont** green, coccoid, cells globose, [5]–(6.1)–7.5–(8.9)–[13] µm (*n*=120) in diameter.

Chemistry. – Divaricatic acid, zeorin, traces of nordivaricatic acid, and ± an unidentified anthraquinone pigment. Spot tests: K- (or K+ purple when pigment is present), C± pink, KC+ pink, P-, UV+ blue-white.

Ecology and distribution. – The vast majority of collections of *Lepraria pacifica* were found on conifer taxa endemic to western North America (figure 51). It is the dominant *Lepraria* species in the redwood forests of the Coastal Range and the Sierra Nevada Mountains in central and northern California, becoming less frequent farther north in coastal British Columbia where it is replaced by the ecologically similar *L. torii*.

Conservation status. – *Lepraria pacifica* is a North American endemic whose core geographic distribution is western North America. Although it is common in some areas, many of the forests where *L. pacifica* occurs are threatened by disruptions to the fire regime and by changes in overall forest composition and dynamics. The species is not likely in need of conservation measures at present, but should be considered in community management plans as they are developed and implemented.

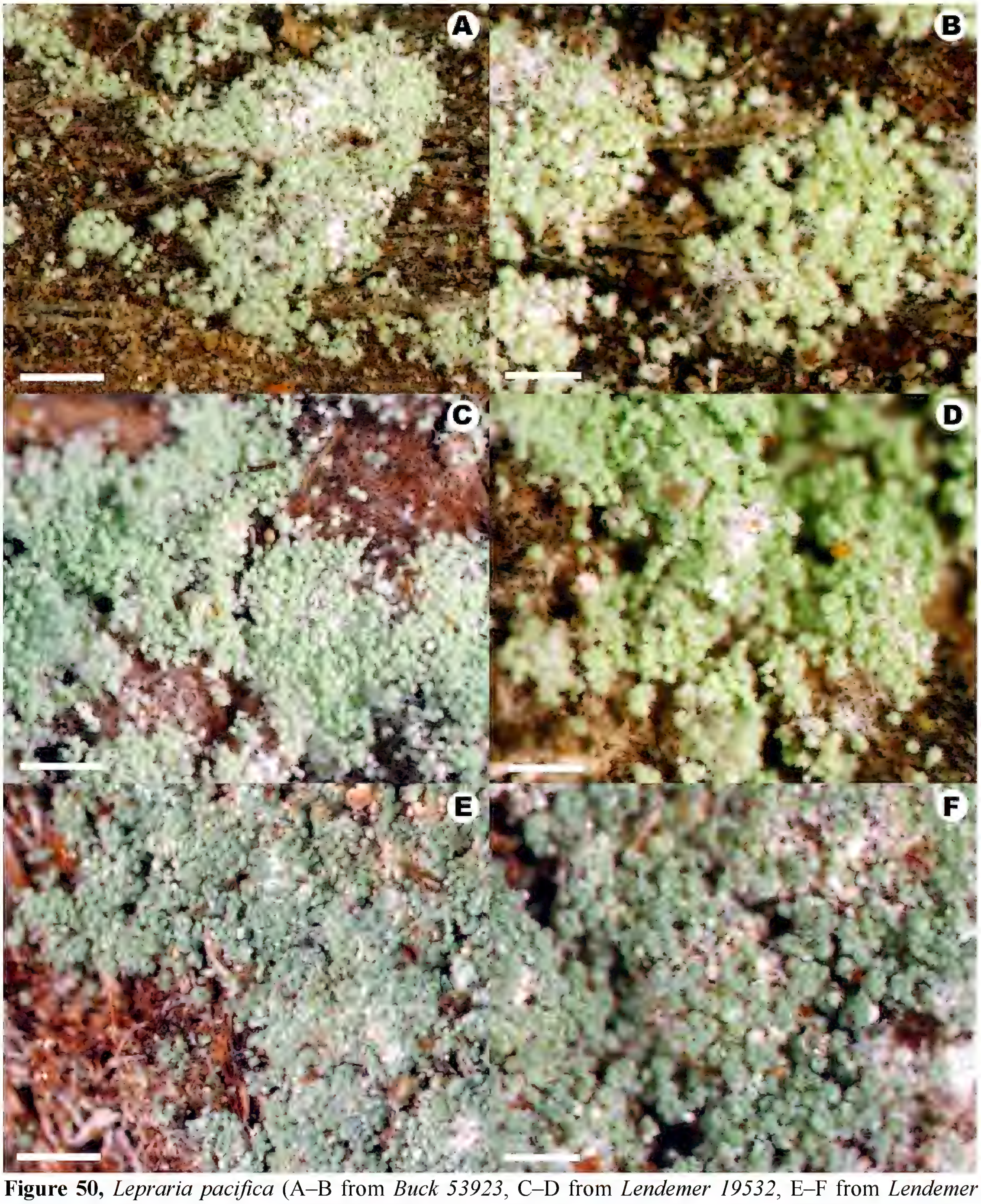

Figure 50, *Lepraria pacifica* (A–B from *Buck 53923*, C–D from *Lendemer 19532*, E–F from *Lendemer 19562*). A,C and E, gross morphology of the thallus (scales = 1.0 mm). B, D and F, detail of the granules (scales = 0.25 mm).

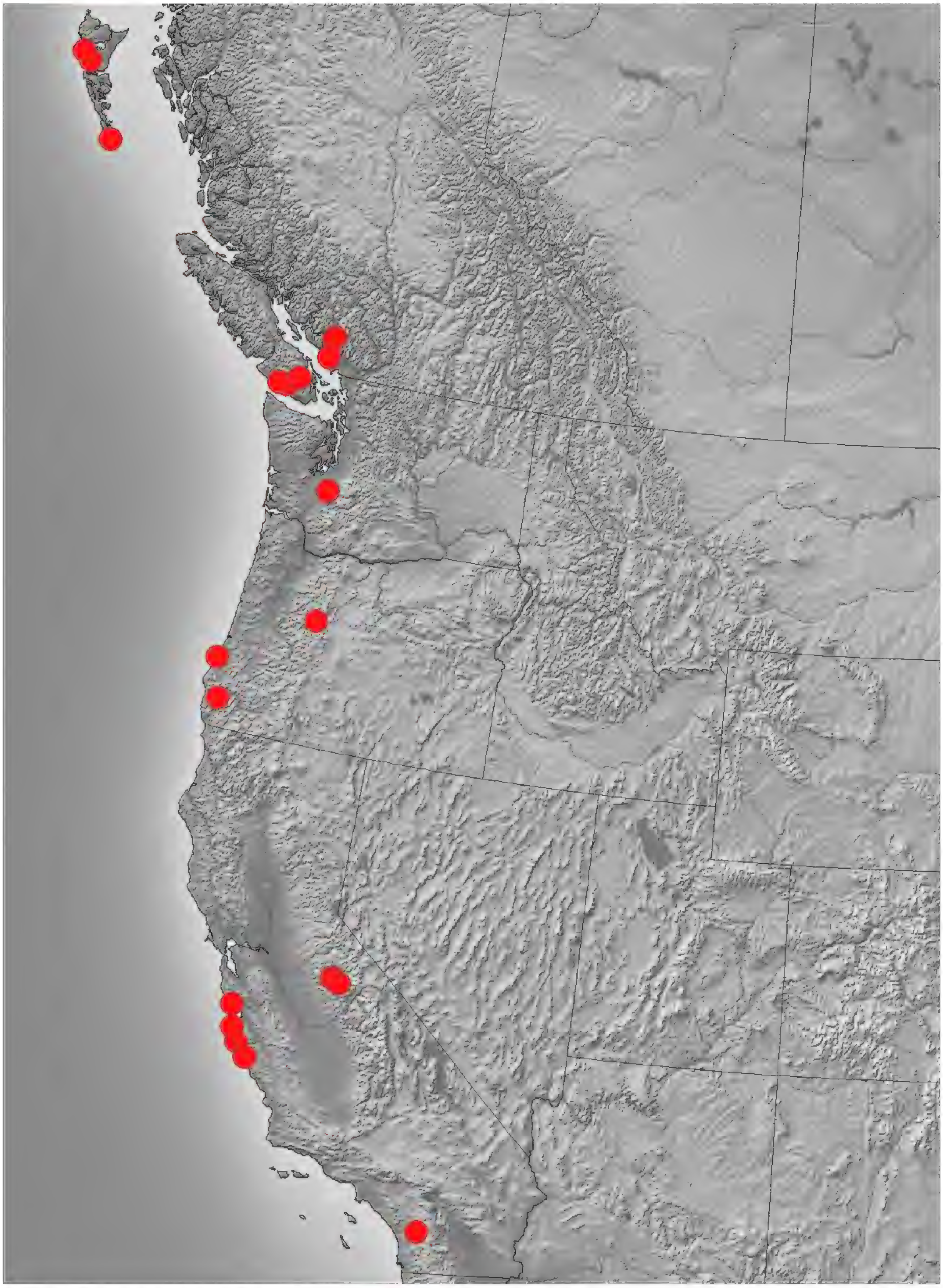

Figure 51, geographic distribution of *Lepraria pacifica* based on the specimens examined for this study.

Discussion. – *Lepraria pacifica* was described by Lendemer (2011c) to accommodate the populations of *Lepraria* in western North America that produce divaricatic acid and zeorin. These populations had previously been referred to *L. incana*. However, molecular phylogenetic analyses performed in the above study recovered sequences of them as distinct from that taxon. In western North America only *L. torii* could potentially be confused with *L. pacifica*, as both species have greenish colored aggregate thalli of variable thickness. *Lepraria torii* differs from *L. pacifica* in the production of roccellic/angardianic acid and fumarprotocetraric acid. *Lepraria pacifica* is most similar to the allopatric species *L. hodkinsoniana*. Both species produce divaricatic acid and zeorin, however, nordivaricatic acid is typically present as a minor assessor in *L. pacifica* while it is not detectable in *L. hodkinsoniana* with TLC.

Selected additional specimens examined (51 total seen from North America; specimens with anthraquinones are indicated as anthraq+). – **CANADA. BRITISH COLUMBIA.** CAPITAL REGIONAL DIST.: Vancouver Island, Lizard Lake Loop, Lizard Lake, 26.v.2010, on conifer, *J.C. Lendemer 22391 & A. Moroz* (NY). GREATER COWICHAN VALLEY REGIONAL DIST.: Vancouver Island, between Riverbottom Rd. and Cowichan River, 25.v.2010, on log, *J.C. Lendemer 22358 & A. Moroz* (NY). GREATER VANCOUVER REGIONAL DIST.: Vancouver, Pacific Spirit Regional Park, Spanish Bank Creek area, 9.v.2009, on *Acer*, *W.R. Buck 54625* (NY). SQUAMISH-LILLOOET REGIONAL DIST.: Stawamus Chief Provincial Park, along Lower Falls Trail, 11.v.2009, on rock, *W.R. Buck 54722* (NY). QUEEN CHARLOTTE ISLANDS: Kunghit Island, Rose Harbour, 4.vii.1971, on *Thuja*, *I.M. Brodo 17682* (NY); Graham Island, along the road to Rennell Sound, 15.vii.2010, on red cedar, *J.A. Harpel 48499 & S. Joya* (NY). **U.S.A. CALIFORNIA.** MARIPOSA CO.: Yosemite National Park, 1 km E of Hogdon Meadow on Old Big Oak Flat Rd. where it crosses Hazel Green Creek, 19.ix.2009, on *Calocedrus*, *J.C. Lendemer 19525* (NY); Yosemite National Park, bottom of Tuolumne Grove, 19.ix.2009, on burnt log, *J.C. Lendemer 19579-A* (NY). MONTEREY CO.: Santa Lucia Mountains, Lime Kiln State Park, 16.viii.2008, on redwood, *K. Knudsen 10159* (NY, UCR; anthraq+); Point Lobos State Reserve, Allan Memorial Grove, 14.v.2009, on *Cupressus*, *K. Knudsen 11125* (NY, UCR). RIVERSIDE CO.: Peninsular Range, Palomar State Park, Palomar Mountain, Chimney Creek, 17.v.2005, on *Calocedrus*, *K. Knudsen 2981 & M. Knudsen* (UCR). SANTA CRUZ CO.: The Forest of Nisene Marks State Park, along trail from parking area at Porter Family Picnic Area, 13.vii.2008, on *Sequoia*, *W.R. Buck 23923* (NY). **OREGON.** COOS CO.: South Slough National Estuarine Research Reserve, 12 km SW of town of Coos Bay, ix.2008, on *Chamaecyparis*, *B. McCune 29769* (NY, OSC). LINN CO.: W side of Clear Lake, S of Clear Lake Resort, i.2009, on wood, *B. McCune 29887* (NY, OSC). **WASHINGTON.** THURSTON CO.: between Bald Hill and Bald Hill Lake, 20 km SE of town of Yelm, iii.2010, on *Thuja*, *B. McCune 30504* (NY, OSC).

22) *Lepraria rigidula* (B. de Lesd.) Tønsberg, Sommerfeltia 14: 205. 1992.

Crocynia rigidula B. de Lesd. *in* Hue, Bull. Soc. Bot. France 71: 331. 1924. TYPE: **SCOTLAND:** Perth, Pitlochry, byside of R. Tummel, vi.1914, *J. McAndrew s.n.* (E [n.v.], holotype).

FIGURES 52 AND 53.

Description. – **Thallus** crustose, leprose, aggregated, discontinuous and not stratified, initially composed of isolated granules that divide to form aggregations, eventually merging to form a thin crust (<0.1 mm thick), off-white or gray-blue in color; **hyphae** hyaline, [2.1]–(2.5)–3.1–(3.6)–[5.2] µm (*n*=64) in width, septate, secund, obscured by a thick layer of POL+ crystals that dissolve in KOH; **prothallus** persistent; **hypothallus** absent; **rhizohyphae** absent; **granules** globose, [24]–(30)–43–(55)–[78] µm (*n*=96) in diameter, ecorticate, well organized and discrete, remaining distinct and not forming compound units, often with projecting prothalline hyphae persisting into maturity; **photobiont** green, coccoid, cells globose, [6]–(7.7)–9.7–(11.8)–[13.3] µm (*n*=64) in width.

Chemistry. – Atranorin, nephrosteranic acid. Spot tests: K+ yellowish, C-, KC-, P-, UV-.

Ecology and distribution. – *Lepraria rigidula* is rare but widespread in boreal and arctic regions of North America (figure 53). Rare disjunct populations extend its geographic distribution southwards in mountainous regions of both the East and West. The species typically occurs on bryophytes and humus in sheltered microhabitats. Rarely it grows directly on non-calcareous rocks or on the bark of trees (though often at the base). Although I have not conducted extensive fieldwork in the vicinity of major northwestern

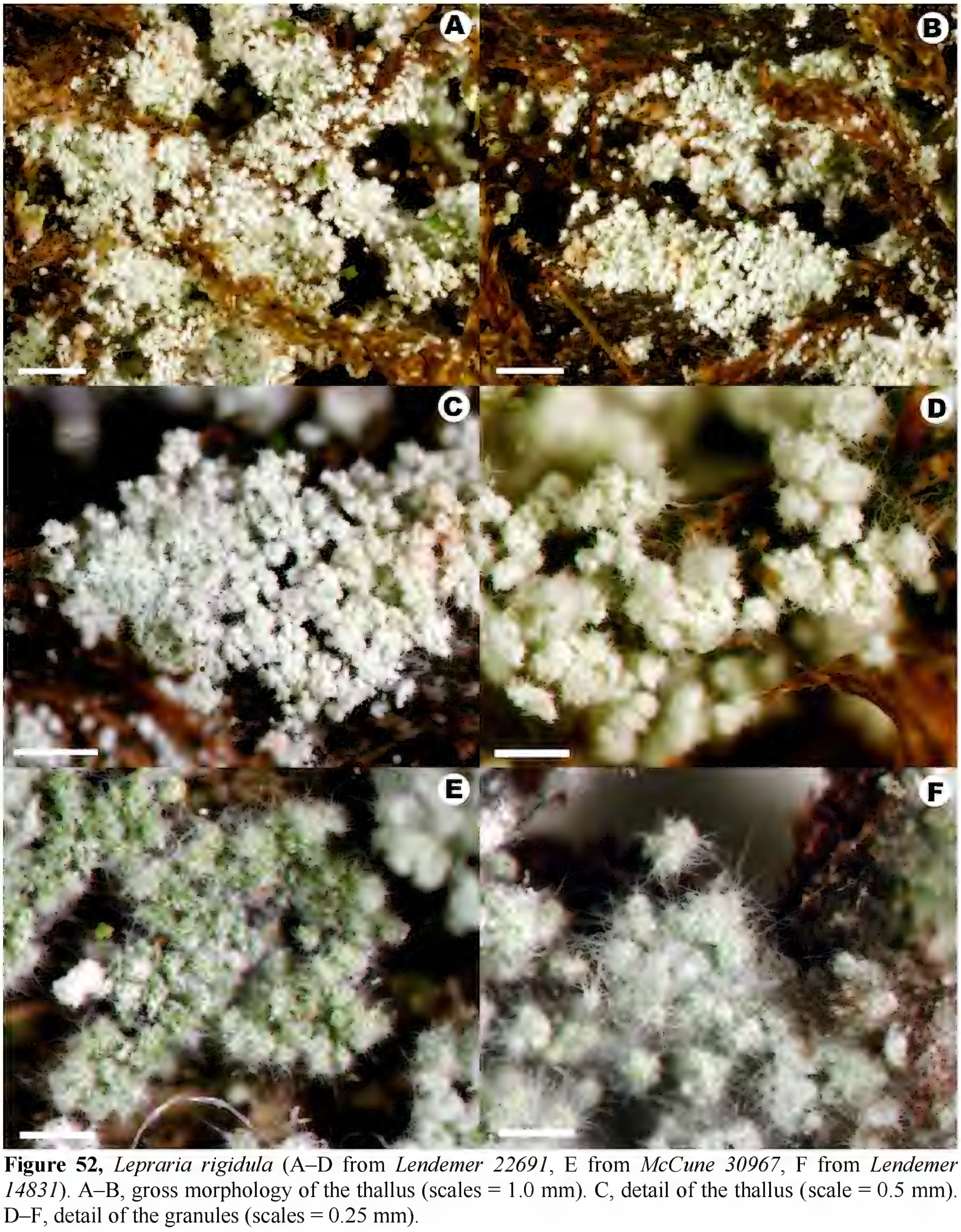

Figure 52, *Lepraria rigidula* (A–D from *Lendemer 22691*, E from *McCune 30967*, F from *Lendemer 14831*). A–B, gross morphology of the thallus (scales = 1.0 mm). C, detail of the thallus (scale = 0.5 mm). D–F, detail of the granules (scales = 0.25 mm).

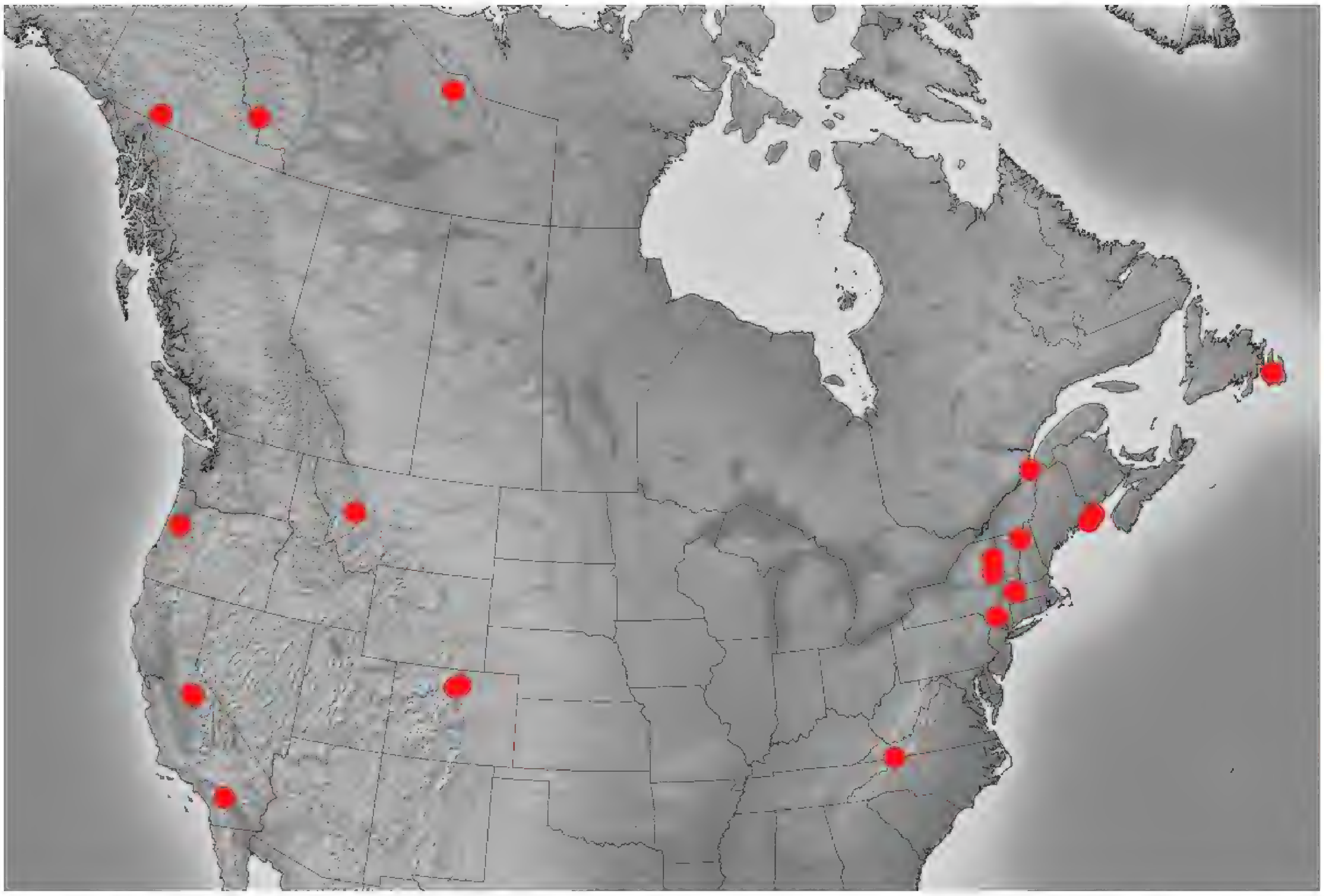

Figure 53, geographic distribution of *Lepraria rigidula* based on the specimens examined for this study.

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cities such as Seattle and Vancouver, Tønsberg (pers. comm.) has noted the occurrence of the species in those urban areas.

Conservation status. – This species is infrequent; however, considering its wide geographic distribution and ecological amplitude it is unlikely in need of conservation measures. The rare disjunct populations in more southerly mountainous regions should be monitored to determine the potential impact of climate change.

Discussion. – *Lepraria rigidula* is a distinctive species with an aggregate thallus and granules which the projecting prothalline hyphae tend to persist into maturity (figure 51D–F). These features, coupled with the presence of nephrosteranic acid, serve to distinguish the species from all its North American congeners. *Lepraria humida* and *L. jackii* are the two species most likely to be confused with *L. rigidula* because they are sympatric, have aggregate thalli, ecorticate granules, and produce fatty acids as well as atranorin. *Lepraria humida* typically occurs directly on rocks, rather than on organic matter and bryophytes, and differs in producing rangiformic/jackinic acid rather than nephrosteranic acid. *Lepraria jackii* is ecologically similar to *L. rigidula*.However, it produces roccellic/angardianic acid and rangiformic/jackinic acid rather than nephrosteranic acid. Both *L. humida* and *L. jackii* also do not typically have granules in which the prothalline hyphae persist to maturity.

It should be noted that *Lepraria rigidula* was mentioned as having a hypothallus in the morphological scheme presented by Lendemer (2011a). This was, however, based on a misinterpretation of the thallus, and further study showed that in fact the species has an aggregate thallus. In some ways, *L. rigidula* is morphologically similar to *L. lanata* in that the prothalline hyphae extend from the granules and cause them to adhere to each other and the substrate. In *L. lanata* this phenomenon causes the granules to collect and form massive globose aggregations that resemble tiny cotton calls. However, in *L. rigidula* this occurs within individual granules.

Selected specimens examined (31 total seen from North America). – **CANADA. NORTHWEST TERRITORIES:** MACKENZIE DIST.: Mackenzie Mountains, Nahanni National Park, small lake 6 km W of Hole-in-the-Wall Lake, 13.vii.1977, on humus, *T. Ahti 32869c* (H, NY). **QUEBEC.** KAMOURASKA CO.: Sainte-Anne de la Pocatière, 27.v.1935, on N side of rock, *E. Lepage 5* (NY). **CHILE. BÍO BÍO PROV.:** Alto Bío Bío, along road 1.6 km S of Chenqueco, 12.iv.2009, on *Nothofagus*, *J.C. Lendemer et al. 16150* (NY). **U.S.A. CALIFORNIA.** MARIPOSA CO.: Yosemite National Park, vicinity of base of Bridal Veil Falls, 22.ix.2009, on *Calocedrus*, *J.C. Lendemer 19707* (NY). RIVERSIDE CO.: San Bernardino National Forest, San Jacinto Mountains, North Fork of the San Jacinto River, 6.x.2008, on mosses, in overhang, *J.C. Lendemer 14812 & K. Knudsen* (NY). **COLORADO.** BOULDER CO.: Rocky Mountain National Park, Wild Basin, vicinity of Calypso Cascades, 27.vi.1962, on bryophytes, *R.A. Anderson 2110* (COLO). **MAINE.** WASHINGTON CO.: Town of Cutler, Cutler Coastal Public Lands, Loop Trail via Black Point Cove Cutoff, 8.vi.2010, on moss, *J.C. Lendemer 22691* (NY). **MONTANA.** LAKE CO.: Lower S Woodward Creek, 12.vii.1977, on moss, *B. McCune 7531* (NY). **NEW HAMPSHIRE.** CHESHIRE CO.: Mount Monadnock State Park, White Arrow Trail on S slope of Mt. Monadnock, 5.iv.1992, on *Betula*, *T. Ahti et al. 51123* (NY). **NEW YORK.** ESSEX CO.: Town of Keene, Adirondack Park, Chapel Pond, 19.ix.2004, on *Acer*, *R.C. Harris 50038* (NY). ULSTER CO.: along trail to top of Slide Mountain from Winisook, 14.ix.1980, on moss, *R.C. Harris 13480* (NY). **OREGON.** BENTON CO.: 1840 NE Seavy Ave., just NE of Corvallis, xii.2010, on wooden arbor, *B. McCune 30967* (NY). **VERMONT.** ESSEX CO.: summit of East Mountain, 1.viii.1991, on *Abies*, *S. Selva et al. 4755A* (UMFK). **VIRGINIA.** GRAYSON CO.: Grayson Highlands State Park, Wilburn Ridge, 12.ix.1991, on *Picea*, *R.C. Harris 26869* (NY).

23) *Lepraria squamatica* Elix, Australasian Lichenology 58: 20. 2006. **AUSTRALIA. NORTHERN TERRITORY:** Tabletop Range, Litchfield National Park, 25 km SW of Batchelor, burnt *Eucalyptus* woodland, with a dense understory of *Grevillea*, *Owenia*, and *Acacia*, 2.vii.1991, on charred wood, *J.A. Elix et al. 27513* (CANB [n.v.], holotype).

FIGURES 54 AND 55.

Description. – **Thallus** crustose, leprose, placodioid, continuous and typically distinctly bi-layered, initially forming small discrete thalli which expand marginally, overlap and become confluent to form a thick crust (0.2–0.3 mm thick), light gray-blue in color; **hyphae** hyaline, [1.5]–(2.2)–2.7–(3.2)–[4] µm (*n*=66) in width, septate, secund, obscured by a thick layer of POL+ crystals that dissolve in KOH; **prothallus** disappearing with age; **hypothallus** a thin, often poorly developed layer of loosely intertwined hyphae surrounding and subtending the granules, extending outward from the edge of the thallus; **rhizohyphae** present, pale to dirty brownish; **granules** globose, [22]–(29)–42–(54) –[80] µm (*n*=132) in diameter, ecorticate, well organized and discrete, not typically forming compound units of multiple granules; **photobiont** green, coccoid, cells globose, [5.6]–(6.9)–8.8–(10.7)–[14.4] µm (*n*=66) in diameter.

Chemistry. – Squamatic acid, baeomycesic acid, protocetraric acid, numerous additional other substances present as minor or trace accessories (Elix 2006). Spot tests: K+ dirty yellow, C-, KC-, P+ orange-red, UV+ blue-white.

Ecology and distribution. – *Lepraria squamatica* is a rare species of the Coastal Plain of southeastern North America, where it is essentially restricted to tropical and subtropical regions of central and northern Florida, extending as far north as Cumberland Island in Georgia (figure 55). The species was originally described from Australia by Elix (2006) and its occurrence in North America may indicate that it is widespread in tropical regions of the world. It typically occurs in humid habitats such as conifer swamps or riparian corridors on conifers (*Chamaecyparis*, *Pinus*, *Taxodium*) and more rarely on *Sabal* or on hardwoods (*Quercus*).

Conservation status. – *Lepraria squamatica* is rare in North America, and warrants the same treatment as *L. aurescens*.

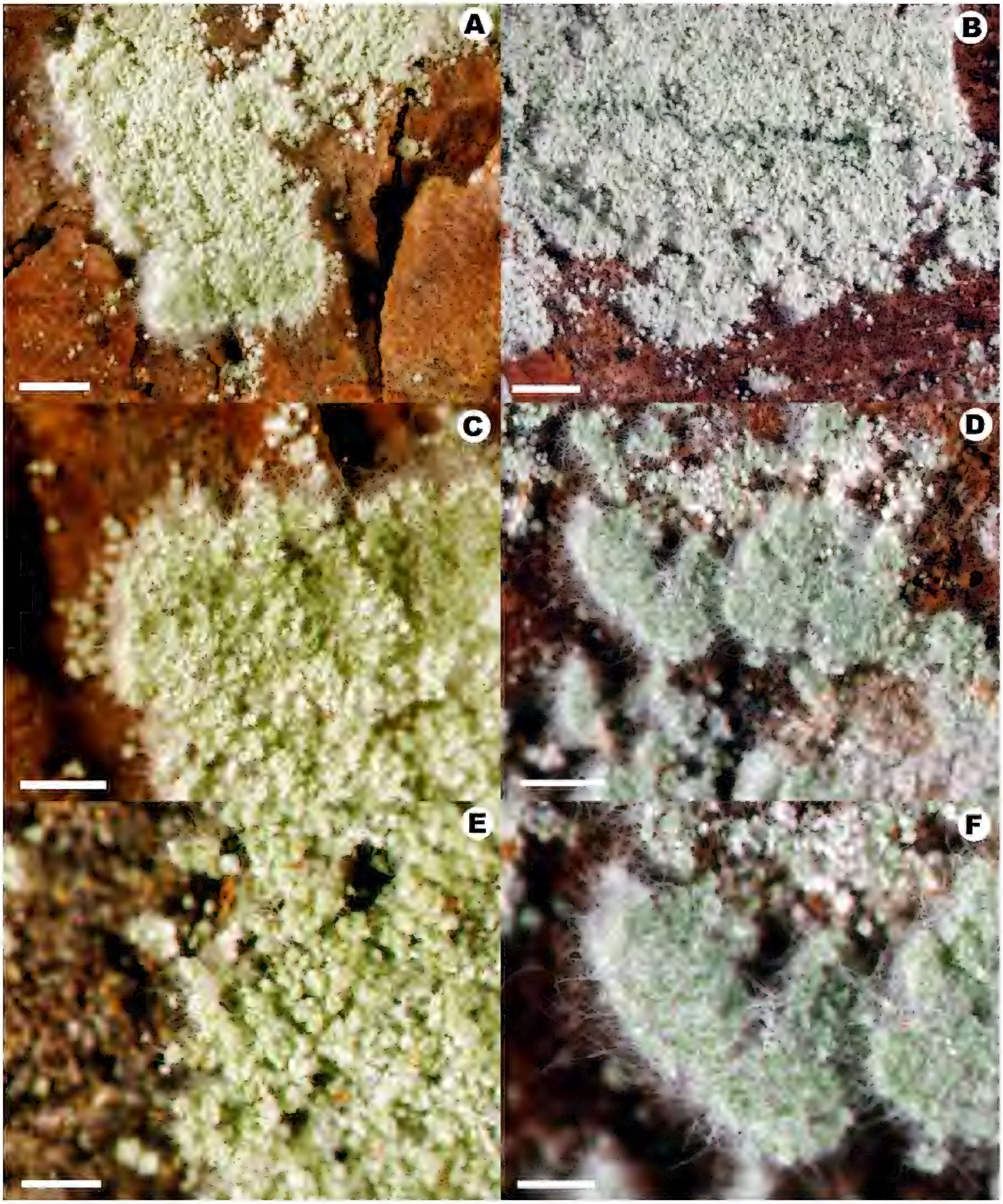

Figure 54, comparison of populations of *Lepraria squamatica* from North America (left, *Buck 54362*) and Australia (right, *Elix 37755*). A–B, gross morphology of the thallus (scales = 1.0 mm). C–D, detail of the thallus (scales = 0.5 mm). E–F, detail of the granules and thallus margins (scales = 0.25 mm).

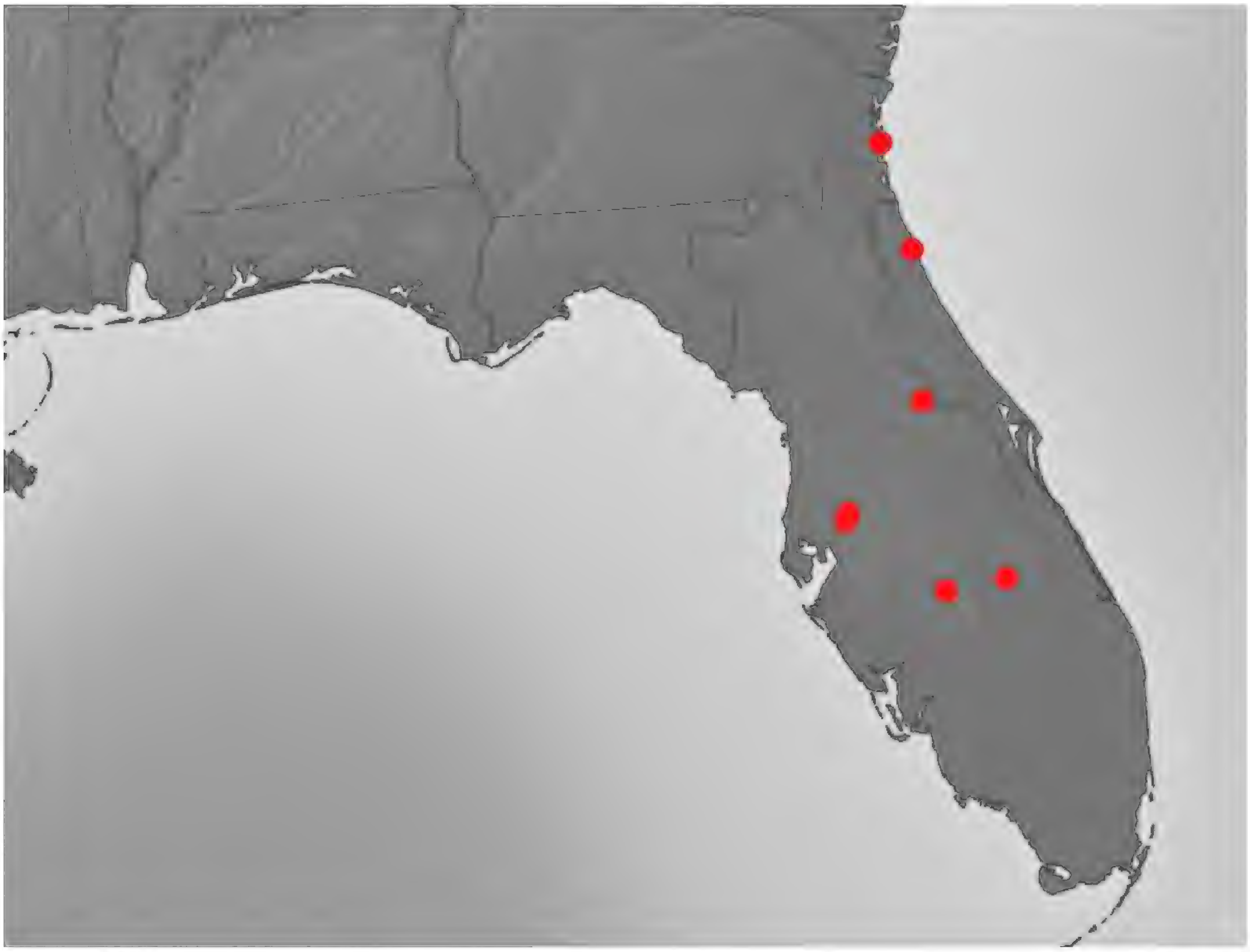

Figure 55, geographic distribution of *Lepraria squamatica* based on the specimens examined for this study.

Discussion. – *Lepraria squamatica* is morphologically and ecologically identical to *L. aurescens*, which differs in the production of thamnolic acid. Both species are entirely sympatric in North America and often occur as mixed populations, which can lead to confusing spot test and TLC results. The easiest way to make usable voucher specimens is to sort pieces of bark under long wave UV light because the squamatic acid in *L. squamatica* fluoresces. Interestingly the species is also morphologically quite similar to *L. harrisiana*, another species of humid habitats, especially conifer swamps, in the southeastern Coastal Plain. That species differs in producing atranorin, zeorin, and pallidic acid.

Selected specimens examined (16 total seen from North America). – **AUSTRALIA. NORTHERN TERRITORY:** Litchfield Park, 39 km SE of Batchelor, 4.vii.1991, on *Eucalyptus*, *H. Streimann 48244* (NY); Litchfield Park, below Florence Falls, 42 km SW of Batchelor, 6.viii.2005, on tree trunk, *J.A. Elix 37755* (NY). **U.S.A FLORIDA.** HIGHLANDS CO.: Highlands Hammock State Park, 30.iv.1964, on *Sabal*, *B. Moore 1059* (DUKE, NY). HILLSBOROUGH CO.: Hillsborough River State Park, 15.v.1964, on *Sabal*, *B. Moore 1342* (DUKE, NY). LAKE CO.: Seminole State Forest, along Atula Rd. from Cassia Trailhead, 8.iii.2009, on *Quercus*, *J.C. Lendemer 15843 & W.R. Buck* (NY). MARION CO.: Ocala National Forest, NE of Mill Dam Lake, 8.xii.1987, on *Quercus*, *R.C. Harris 21096* (NY). OKEECHOBEE CO.: Viking Property, ~1 mi NW of jct CR 700A and CR 724, 28.iii.1998, on *Eucalyptus*, *R.C. Harris 41879* (NY). ST. JOHNS CO.: South Ponte Vedra Beach, Guana Tolomato Matanzas National Estuarine Research Reserve, 28.xi.2008, on *Pinus*, *W.R. Buck 54362* (NY). **GEORGIA.** CAMDEN CO.: Cumberland Island, Southcut Rd., 24.x.2004, on *Quercus*, *S.Q. Beeching s.n.* (NY).

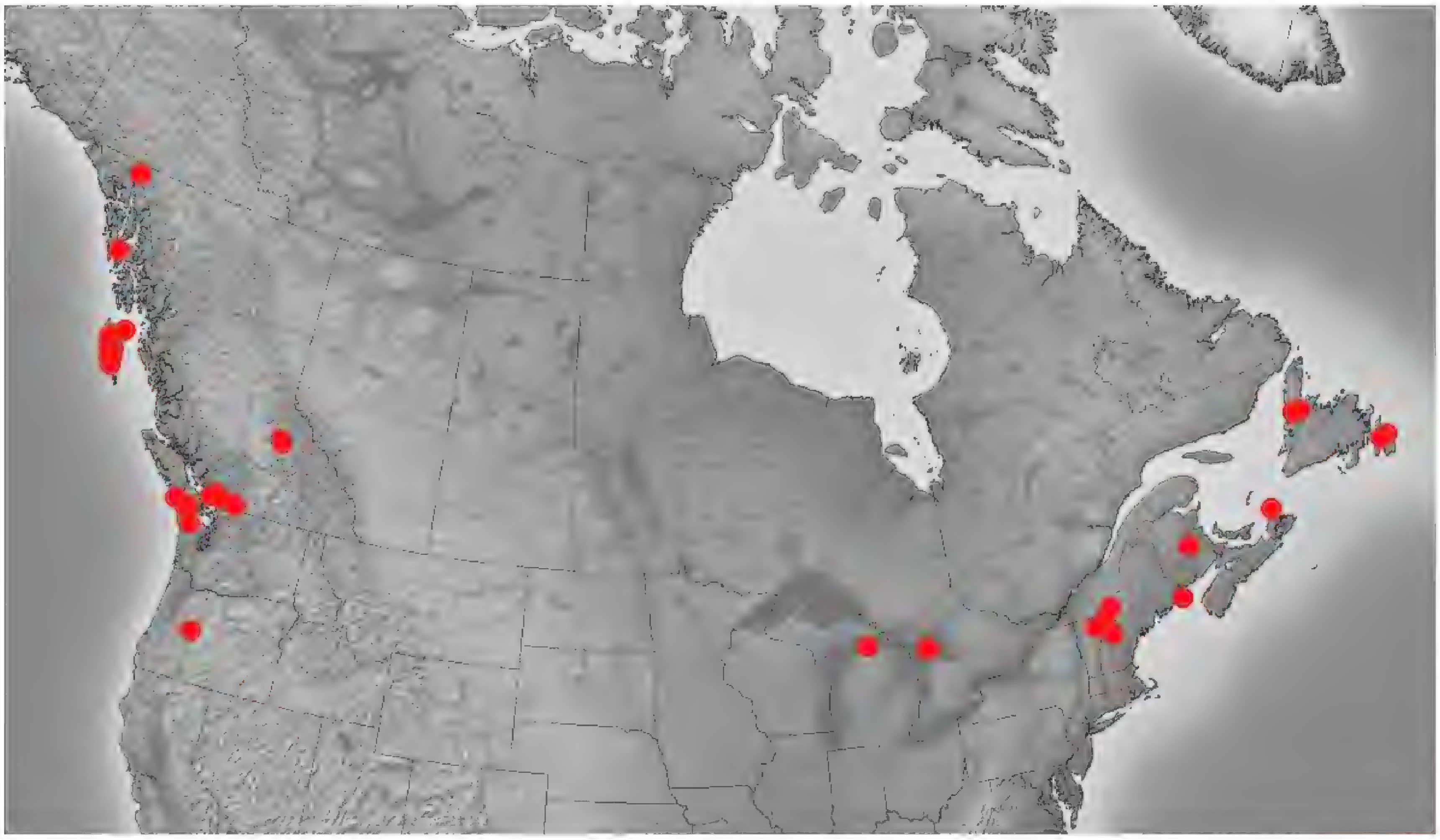

Figure 56, geographic distribution of *Lepraria torii* based on the specimens examined for this study.

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24) ***Lepraria torii*** **Pérez-Ortega & T. Sprib.,** Graphis Scripta 21: 37. 2009. TYPE : **U.S.A ALASKA.** SKAGWAY BOROUGH : Chilkoot Trail, along trail between Canyon City and Pleasant Camp, 28.vii.2008, on *Tsuga*, *S. Pérez-Ortega 1061 & T. Spribille* (US [n.v.], holotype; NY!, isotype).

FIGURES 56 AND 57.

Description. – **Thallus** crustose, leprose, aggregated, discontinuous and not stratified to continuous and weakly stratified, initially composed of isolated granules that divide to form aggregations, eventually merging to form a crust of variable thickness (0.1–0.3 mm), distinctly greenish in color; **hyphae** hyaline, [1.8]–(2.2)–2.7–(3.1)–[4.5] µm (*n*=64) in width, septate, secund, obscured by a thick layer of crystals that partially dissolve in KOH; **prothallus** persistent and often readily visible; **hypothallus** typically indistinct, poorly developed or absent; **rhizohyphae** absent; **granules** globose, [19]–(28)–37–(46)–[62] µm (*n*=133) in diameter, ecorticate initially and eventually forming a poorly developed pseudocortex, well organized and discrete; **photobiont** green, coccoid, cells globose, [5]–(6.2)–8.1–(9.9)–[13.2] µm (*n*=64) in diameter.

Chemistry. – Roccellic/angardianic acid, fumarprotocetraric acid, ± traces of protocetraric acid, ± atranorin (very rare). Spot tests: K-, C-, KC-, P+ orange-red, UV-.

Ecology and distribution. – As has been discussed by Lendemer (2010a) *Lepraria torii* is a common species of the coastal rainforests of the Pacific Northwest, with infrequent disjunct occurrences in the Canadian Maritimes, Great Lakes, and northern Appalachians (figure 56). The species typically occurs on the bark of conifers, or more rarely on the bark of hardwoods in conifer-dominated habitats (such as *Thuja* swamps). In the Pacific Northwest, the species is ubiquitous and often the dominant member of some low-light high humidity rainforest communities.

Conservation status. – At the present time this species does not likely warrant conservation measures. However, excessive logging and other anthropogenic influences on native forests could have a negative impact on the species. It is noteworthy that all the localities where the author has collected the species have been mature forests without recent disturbance.

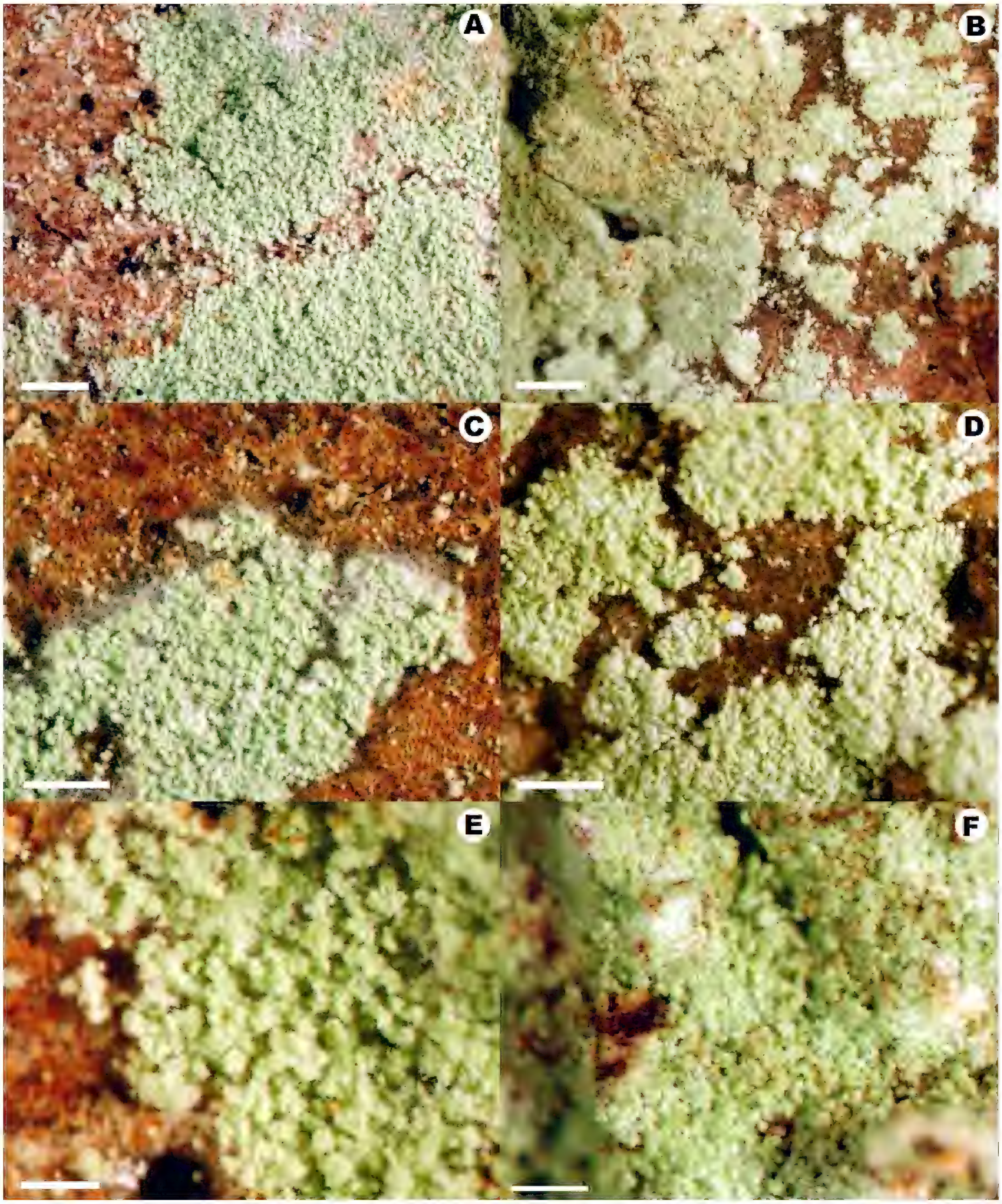

Figure 57, comparison of populations of *Lepraria torii* from western North America (left, *Lendemer 22423*) and eastern North America (right, *Lendemer 27536*). A–B, gross morphology of the thallus (scales = 1.0 mm). C–D, detail of the thallus (scales = 0.5 mm). E–F, detail of the granules (scales = 0.25 mm).

Discussion. – Due to the production of fumarprotocetraric acid in *Lepraria torii*, the species is most likely to be confused with *L. nivalis*. That species differs in lacking roccellic/angardianic acid, typically producing atranorin, and in having a *finkii*-type placodioid thallus. It also often has a white or blue-white hue in the field, whereas the thallus of *L. torii* always has a distinctly greenish coloration, resembling *L. pacifica* or some forms of *L. finkii*. The thallus type of *L. torii* can also be difficult to interpret because the occurrence in extremely humid habitats seems to induce the development of a thick thallus. This phenomenon is similar to that observed in another species of the Pacific Northwest, *L. pacifica* (Lendemer 2011c). Based on the specimens examined, I consider *L. torii* to have an aggregate thallus that displays the same degree of morphological variability as *L. pacifica*.

Selected specimens examined (60 total seen from North America). – **CANADA. BRITISH COLUMBIA.** CAPITAL REGIONAL DIST.: Vancouver Island, Lizard Lake Loop, Lizard Lake, 26.v.2010, on wood, *J.C. Lendemer 22387 & A. Moroz* (NY). DEWDNEY-ALOUETTE DIST.: Golden Ears Provincial Park, along road from head of Menzies Trail, 10.v.2009, on *Populus*, *W.R. Buck 54678* (NY). GREATER VANCOUVER REGIONAL DIST.: Lynn Headwaters Regional Park, E side of Lyn Creek, ~4 km N of terminus of Lynn Creek Rd., 24.v.2010, on conifers, *J.C. Lendemer 22328 & A. Moroz* (NY). QUEEN CHARLOTTE ISLANDS: Haida Gwaii, Graham Island, along the road to Rennell Sound, 15.vii.2010, on red cedar, *J.A. Harpel 48502 & S. Joya* (NY). **NEWFOUNDLAND AND LABRADOR.** NEWFOUNDLAND: Island of Newfoundland, Avalon Peninsula, Hall's Gully, 9.7 km W of Trans-Canada Hwy on Fox Marsh Resource Rd., 8.ix.2007, on rotting log, *J.C. Lendemer 10138* (NY); White Bay South Region, Main River Reserve, Sop's Arm W, Main River Forest Access Rd., 6.ix.2011, on *Betula*, *T. Ahti 70738j* (H). **NOVA SCOTIA.** INVERNESS CO.: Cape Breton Island, Cape Breton Highlands National Park, along the Benjies Lake Trail, 13.vii.2000, on *Abies*, *S. Selva 8543A & P. Edberg* (UMFK). **ONTARIO.** BRUCE CO.: Bruce Peninsula National Park, Shingle Marsh along road to Halfway Log Dump, 20.ix.2008, under log, *J.C. Lendemer 14331* (NY). **U.S.A. ALASKA:** Washington Bay, Kuiu Island, 15.vii.1947, on spruce, *W.J. Eyerdam 405* (NY). **OREGON.** LANE CO.: H.J. Andrews Experimental Forest, 5.viii.1971, on *Pseudotsuga*, *D. Tracy 33496* (COLO). **MAINE.** AROOSTOOK CO.: T10 R9 WELS, S side of Jack Mountain Rd., 23.viii.1988, on *Picea*, *S. Selva 3548 & B. Hicks* (UMFK). WASHINGTON CO.: Town of Cutler, Cutler Public Reserve Land, Coastal Trail, 4.vii.2008, on bryophytes over rock, *R.C. Harris 54657* (NY). **MICHIGAN.** CHEBOYGAN CO.: W of Hebron Mail Rd., 24.vii.1974, on *Thuja*, *R.C. Harris 9204* (NY). **NEW HAMPSHIRE.** COOS CO.: Town of Stewartstown, Hurlbert Swamp Preserve, 17.v.2008, on rotten root of *Abies*, *R.C. Harris 54439* (NY). **VERMONT.** CALEDONIA CO.: Town of Wheelock, Wheelock Farm, 22.x.2010, on *Betula*, *J.C. Lendemer 27536 & M. Sundue* (NY). **WASHINGTON.** CLALLAM CO.: Olympic National Park, Soleduck Hot Springs, 7.viii.1967, on *Tsuga*, *I.M. Brodo 13240 & M. Shchepanek* (DUKE).

25) *Lepraria vouauxii* (Hue) R.C. Harris *in* Egan, Bryologist 90: 163. 1987.

Crocynia vouauxii Hue, Bull. Soc. Bot. France 71: 392. 1924. TYPE: **FRANCE:** Meurthe-et-Moselle, Nancy, [Jarville]la-Malgrange, on bark and mosses on *Ulmus*, *L. Vouaux s.n. = Lich. Gall. Praec. Exs. #300* (BM [n.v.], lectotype [selected by Laundon 1989].

Leproloma vouauxii (Hue) J.R. Laundon, Lichenologist 21: 13. 1989.

FIGURES 58 AND 59.

Description. – **Thallus** crustose, leprose, placodioid, without crisped margins, continuous and distinctly bi-layered, initially forming small discrete thalli which expand marginally, overlap, and become confluent to form a thick crust (0.2–0.4 mm thick), distinctly yellowish in color; **hyphae** hyaline, [1.4]–(2.1)–2.7–(3.3)–[4.2] µm (*n*=97), septate, secund, obscured by a layer of POL+ crystals that do not dissolve in KOH; **prothallus** disappearing with age; **hypothallus** a variably developed layer of densely intertwined hyphae surrounding and subtending the granules, sometimes outward from the edge of thallus; **rhizohyphae** uncommon, not pigmented; **granules** globose, [24]–(32)–47–(61)–[90] µm (*n*=97), ecorticate, well organized and discrete, rarely forming compound units, sometimes separating from the hypothallus and then producing abundant projecting hyphae; **photobiont** green, coccoid, cells globose, [4.8]–(6.3)–8.9–(11.5)–[18] µm (*n*=97).

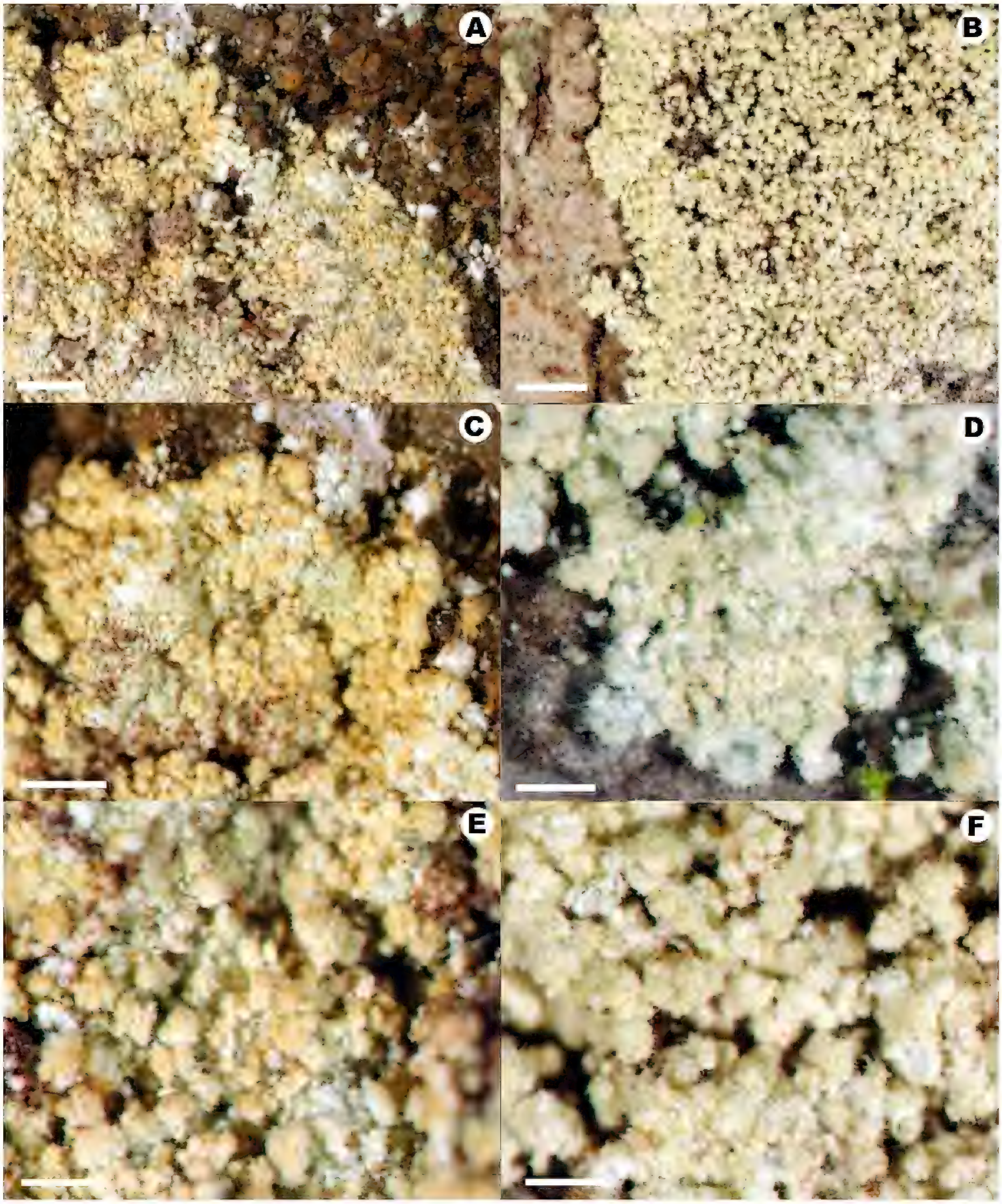

Figure 58, comparison of typical *Lepraria vouauxii* (right, *Lendemer 18816*) and its unnamed "pigmented" variant (left, *Buck 49831*). A–B, gross morphology of the thallus (scales = 1.0 mm). C–D, detail of the thallus margin (scales = 0.5 mm). E–F, detail of the granules (scales = 0.25 mm).

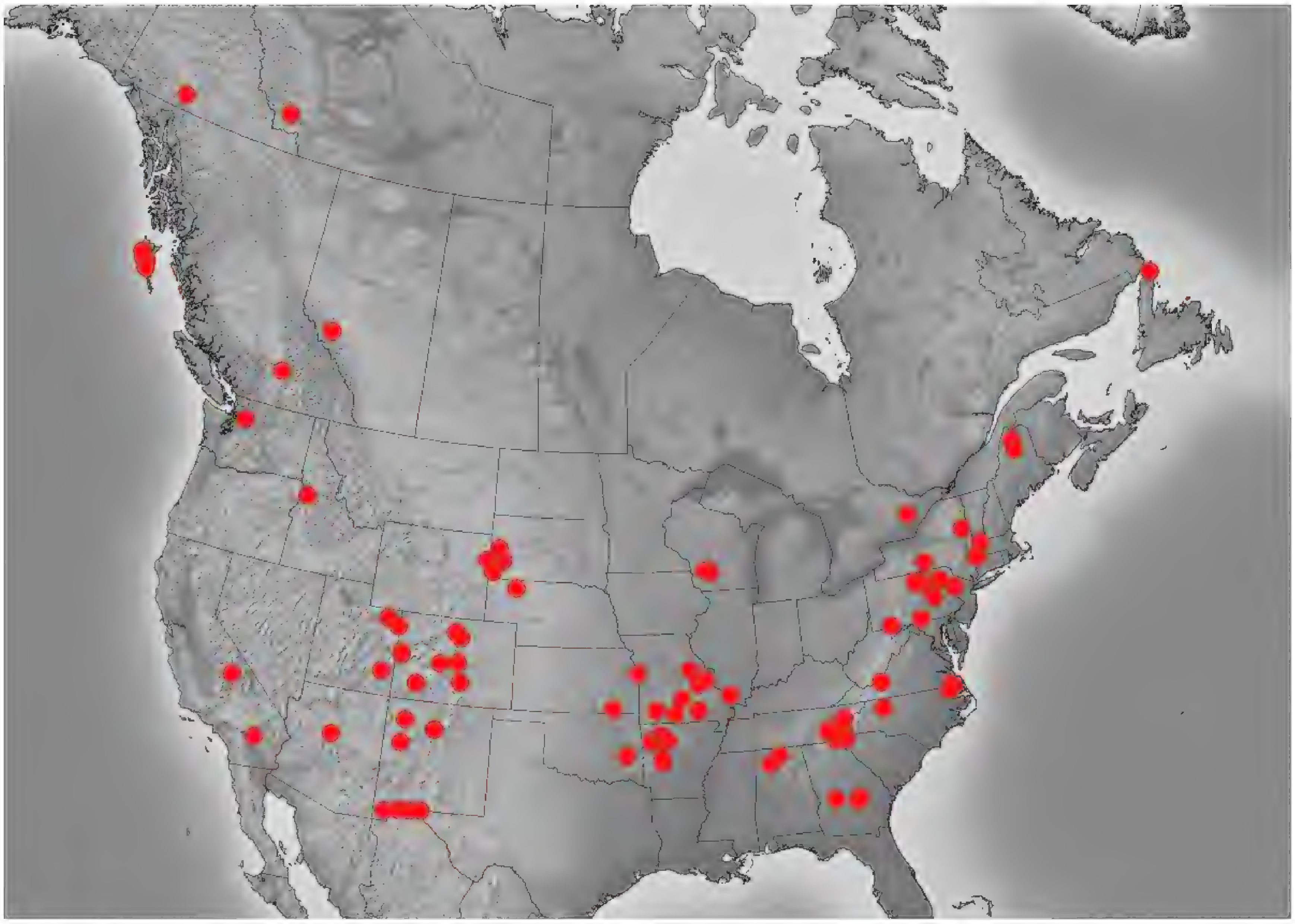

Figure 59, geographic distribution of *Lepraria vouauxii* based on the specimens examined for this study.

Chemistry. – Pannaric acid 6-methylester, pannaric acid (tr.), oxypannaric acid 6-methylester (minor), ± roccellic/angardianic acid, ± pigments (?), ± atranorin. Spot tests: K- or K+ red turning magenta in pigmented portions, C-, KC-, P+ orange, UV-.

For a more detailed explanation of the compounds produced by *Lepraria vouauxii* the reader sould consult Elix and Tønsberg (2004).

Ecology and distribution. – *Lepraria vouauxii* is uncommon but widespread throughout temperate North America (figure 59). It occurs on the bark of hardwoods, on sheltered non-calcareous rocks, and on organic matter in protected microhabitats. Thalli with the same type of pigmentation that is present in *L. diffusa* var. *chrysodetoides* are apparently restricted to the Ozark Ecoregion and adjacent Ouachita Mountains.

Conservation status. – This species is rare throughout its range in North America, however, it is not likely in need of conservation measures at this time.

Discussion. – *Lepraria vouauxii* is most similar to *L. membranacea*, which is sympatric in the northern portions of the range of *L. vouauxii* and also has a *finkii*-type placodioid thallus. That species differs in producing pannaric acid as the major secondary metabolite rather than pannaric acid 6-methylester. *Lepraria diffusa*, another species that produces dibenzofurans, is restricted to the Pacific Northwest in North America and could be confused with depauperate forms of *L. vouauxii*. That species differs in having an aggregate thallus and in producing oxypannaric acid-2-methylester as the major secondary metabolite. As has been discussed under *L. diffusa*, thalli of that species with orange coloration that has been interpreted as a type of pigment have been recognized as a distinct taxon, *L. diffusa* var. *chrysodetoides*. A similar phenomenon has been observed in *L. vouauxii*; however, such populations have never been recognized formally. These populations appear to be restricted to the Ozark Ecoregion in North America.

Another species that is likely to be confused with *Lepraria vouauxii* is *L. finkii*. That species is ubiquitous in the habitats occupied by *L. vouauxii* and has a similar placodioid thallus. It differs in the production of atranorin, zeorin, and stictic acid.

Selected specimens examined (116 total seen from North America; "pigmented form" as indicated). – **CANADA. ALBERTA:** Whitehorse Creek, ~4 km S of Cadomin on Hwy 40, 1.viii.1995, on bryophytes, *W.R. Buck 27983* (NY). **BRITISH COLUMBIA.** QUEEN CHARLOTTE ISLANDS: Haida Gwaii, Morseby Island, 8.v.2010, on *Tsuga*, *B. Shaw 9111* (NY); Graham Island, S side of Keno Inlet, 9.v.2010, on *Chamaecyparus*, *B. Shaw 9171* (NY). **NEWFOUNDLAND AND LABRADOR.** NEWFOUNDLAND: Island of Newfoundland, Avalon Peninsula, Cataracts Provincial Park, 9.ix.2007, on bryophytes, *W.R. Buck 52510* (NY). **ONTARIO.** FRONTENAC CO.: Hwy 7 – Salmon River, N of the Hamlet of Ardendale, 2.iii.2001, on rock, *D. Lewis 512* (NY). **U.S.A. ALABAMA.** MORGAN CO.: near Beaver Creek Swamp Wildlife Refuge, S of I-565 and N of Tennessee River, 2.i.2011, on tupelo, *E. Tripp 1304* (NY). WINSTON CO.: Bankhead National Forest, Sipsey Wilderness, along trail by Sipsey Fork, 25.ix.1992, on *Quercus*, *R.C. Harris 28414* (NY). **ALASKA:** Prince William Sound, Port Wells, 26.vii.1899, on humus, *W. Trelease & D. Saunders s.n.* (DUKE). **ARIZONA.** APACHE CO.: Apache National Forest, along Black River and FSR25, 5.vi.1998, on soil, *C. Bratt 10647* (NY, SBBG). COCHISE CO.: below Herb Martyr Reservoir, Chiricahua Mountains, 30.iii.1961, on limestone, *W.A. Weber S-28053 & D.D. Awasthi* (COLO). YAVAPAI CO.: 8.5 mi NE of Clarkdale, 6.i.2012, on *Grimmia*, *D.C. Thornburg 412-C* (NY). **ARKANSAS.** GARLAND CO.: Ouachita National Forest, NE-facing slope along W side of North Fork Ouachita River, ~0.1 mi S of AR298, 6.x.2010, on soil in overhang, *J.C. Lendemer et al. 26102* (NY, pigmented form). MADISON CO.: Sweden Creek Falls Natural Area, W of CR9, 5.x.2010, on rock, in overhang, *J.C. Lendemer et al. 25955* (NY, pigmented form). NEWTON CO.: Boston Mountains, Ozark National Forest, Alum Cove Recreation Area, 24.iv.1988, on rock, *R.C. Harris 21473* (NY). PERRY CO.: Ouachita National Forest, vicinity of Goat Bluffs along north side of South Fourche LaFave River, 6.x.2010, on soil, in overhang, *J.C. Lendemer et al. 26025* (NY, pigmented form). **CALIFORNIA.** INYO/TULARE CO.: summit of Mt. Whitney, 11.vii.1955, on humus, *H.A. Imshaug 17950-A* (MSC). RIVERSIDE CO.: Mojave Desert, Joshua Tree National Park, Wall Street Canyon, 30.xii.2010, on soil and moss, *K. Knudsen 13477* (UCR). **COLORADO.** BOULDER CO.: Buckingham Park, 5.iii.1950, on soil over rocks, *S. Shushan 5821 & W.A. Weber* (COLO). CUSTER CO.: San Isabel National Forest, 2 mi N of Ophir Campground, 13.vi.1951, on rock, *S. Shushan S-187* (COLO). HINSDALE CO.: Cebolla Creek Campground between Cathedreal and Slumgullion Pass, 29.vii.1964, on humus, *W.A. Wevber L-38425* (COLO). LARIMER CO.: West Moraine Park, 28.vi.1963, on bryophytes, *R.A. Anderson 3925* (COLO). MESA CO.: N end of Colorado National Monument, ~3 mi S of Fruita, 12.v.1955, on soil, *S. Shushan S-4957 & W.A. Weber* (COLO). PARK CO.: Pike National Forest, Eleven Mile Canyon, S of Lake George, 0.5 mi S of Riverside Campground, 22.v.1995, on mosses, *W.A. Weber L-90244 & Corbirgde* (COLO). SAN JUAN CO.: South Mineral Creek Campground, 28.vi.1954, on dead moss, *J. Douglass & M. Douglass s.n.* (COLO). **GEORGIA.** WHEELER CO.: along GA 46 at the Oconee River, 19.iii.1995, on rock, *R.C. Harris 36383* (NY). **ILLINOIS.** JACKSON CO.: Shawnee National Forest, along W side of Cedar Lake, 6.xii.2004, on *Quercus*, *R.C. Harris 50456* (NY). **KANSAS.** CHAUTAUQUA CO.: 2.1 mi NE of Sedan, 4.iv.1954, on rock, *C.L. Kramer 301* (NY). JOHNSON CO.: Overland Park Arboretum and Botanical Garden, 1.5 mi N Aubry, 8.vi.2007, on rock, *C.A. Morse et al. 15306* (KANU). **KENTUCKY.** LETCHER CO.: Line Fork Caverns, edge of Kingdom Come State Park, 15.ix.1991, on rock, *R.C. Harris 27118* (NY). **MAINE.** AROOSTOOK CO.: T13 R10 WELS, SW section of township near end of Rocky Brooky tributary, 1.vii.1987, on *Thuja*, *S. Selva et al. 3100* (UMFK). PISCATAQUIS CO.: T8 R10 WELS, Big Reed Pond TNC Preserve, 6.vi.1986, on *Thuja*, *S. Selva et al. 2427A* (UMFK). **MASSACHUSETTS.** BERKSHIRE CO.: Bartholomew's Cobble, Ashley Falls, 10.vi.1982, on rock, *R.C. Harris s.n.* (NY). FRANKLIN CO.: Town of Rowe, just off Tunnel Road, 3.8 mi NW of Zoar on River Rd., 19.ix.1998, on rock, *R.C. Harris 42267* (NY). **MISSOURI.** LAURENCE CO.: Fall Hollow Gorge along small tributary to Goose Creek, 27.iii.2006, on sandstone, *W.R. Buck 49831* (NY, pigmented form). MONTGOMERY CO.: Graham Cave State Park, 27.x.2001, on sandstone, *W.R. Buck 40609* (NY). **NEBRASKA.** SCOTTS BLUFF CO.: Wildcat Hills State Recreation Area, 10 mi S of Scottsbluff, 29.v.1983, on soil, *R.S. Egan 13473* (NY). **NEW MEXICO.** CIBOLA CO.: El Maplaís National Monument, Hanging Fern Ice Cave, 29.vii.1992, on rock, *D.C. Lightfoot 186B* (COLO). SANDOVAL CO.: Bandelier National Monument, trail from Saint Peters Dome to Breaks of Capulin Canyon, 11.vi.1980, on rock, *W.A. Weber & T. Kelso [L-70627]* (COLO). SAN JUAN CO.: S side of Chaco Wash across from Casa Chiquita ruins, 7.viii.1979, on soil, *L. Sigal & T.H. Nash III 16303* (COLO). **NEW YORK.** ULSTER CO.: Long Path, from Upper Cherrytown Road to Vernooy Kill Falls, 8.v.1993, on *Tsuga*, *R.C. Harris 30420* (NY). **NORTH CAROLINA.** CLAY CO.: Nantahala National Forest, Buck Creek Barren, 1–1.5 mi N of US 64 on Buck Creek Rd., 10.xi.2007, on *Quercus*, *J.C. Lendemer et al. 10873* (NY). HAYWOOD CO.: Great Smoky Mountains National Park, E slopes above (E of) Caldwell Fork, 4.viii.2009, on *Acer*, *J.C. Lendemer 18816 & E. Tripp* (NY). SWAIN CO.: Great Smoky Mountains National Park, Beauregard Ridge, Noland Divide Trail 0–2 mi from parking area on Deep Creek Rd., 14.x.2010, on *Acer*, *J.C. Lendemer et al. 26899* (NY). YADKIN CO.: Lime Rock, 7.viii.1938, on rock, *P.O. Schallert 13439* (NY). **OKLAHOMA.** LATIMER CO.: Robber's Cave State Park, 20.vii.1962, on sandstone, *D. Keck 1684* (NY). **PENNSYLVANIA.** LUZERNE CO.: Ricketts Glen State Park, Adams Falls on Kitchen Creek, 19.ix.2010, on rock in overhang, *J.C. Lendemer 25737 & J. Kunsman* (NY). LYCOMING CO.: State Game Lands No. 133, E shore of Lycoming Creek, N-facing slopes of Batys Mountain, 12.v.2009, on moss in overhang, *J.C. Lendemer 16683 & D. Atha* (NY). SCHUYLKULL CO.: Weiser State Forest, E end of Manhantango Mountain, 20.v.2009, on *Quercus*, *R.C. Harris 55347* (NY). TIOGA CO.: Tioga State Forest, along Colton Rd./West Rim Rd. at jct w/ Spiningwheel [sic] Trail, 13.v.2009, on *Quercus*, *J.C. Lendemer 16880* (NY). **SOUTH DAKOTA.** FALL RIVER CO.: 9 mi N of Edgemont, 15.vii.1960, on rock, *C.M. Wetmore 7509* (MSC, NY). PENNINGTON CO.: Billover Creek (4 mi NW of Hermosa), 25.vi.1961, on rock, *C.M. Wetmore 10291* (MSC, NY). **TENNESSEE.** BLOUNT CO.: Great Smoky Mountains National Park, ~2 mi NE of Happy Valley, Abrams Creek, 30.vi.2010, on *Carpinus*, *R.C. Harris 56396* (NY). **TEXAS.** EL PASO CO.: Franklin Mountains, 1.1 air mi NNE top Anthony's Nose, 4.iii.1979, on rock, *R.D. Worthington 3914* (COLO, UTEP). **UTAH.** UINTAH CO.: BLM (Vernal Office), Snake John Reed, N of US40, 1.viii.2009, on rock, *W.R. Buck 55225* (NY). **VIRGINIA.** SUFFOLK CO.: Dismal Swamp National Wildlife Refuge, Railroad Ditch ¾ mi E of entrance on Desert Rd., 12.xii.2009, on *Nyssa*, *J.C. Lendemer 20381 & B.P. Hodkinson* (NY). **WISCONSIN.** RICHLAND CO.: along Hwy I, 2 mi E of Hub City, 16.viii.1974, on sandstone, *M. Nee 13467* (NY). SAUK CO.: Baraboo Hills, Hemlock Draw Preserve, 4.ix.1998, on rock, *R.C. Harris 42205* (NY). **WYOMING.** WESTON CO.: along US 85 at Soldier Creek (20 mi NNW of Newcastle), 12.viii.1961, on rock, *C.M. Wetmore 11238* (MSC, NY).

26) ***Lepraria xerophila*** **Tønsberg,** Lichen Flora of the Greater Sonoran Desert Region 2: 328. 2004. TYPE: **MEXICO. BAJA CALIFORNIA:** along ridge interior from Punta Santo Tomás, 200 m, chaparral to desert transition, 30.xii.1995, on soil, *T.H. Nash 38224 = Lich. Exs. ASU #229* (ASU [n.v.], holotype; COLO!, NY!, SBBG!, isotype).

FIGURES 60 AND 61.

Description. – **Thallus** crustose, leprose, placodioid with crisped margins, continuous and distinctly bi-layered, initially beginning as singular isolated granules that open apically to form small discrete flat circular thalli which expand marginally, overlap, and become confluent to form a thick crust (0.3–1.0 mm thick), bone white or more commonly dirty brownish in color; **hyphae** hyaline or pigmented, 4–6 µm, septate, secund, obscured by a layer of POL+ crystals that do not dissolve in KOH; **prothallus** disappearing with age; **hypothallus** a variably developed layer of densely intertwined hyphae surrounding and subtending the granules, rarely extending outward from the edge of thallus; **rhizohyphae** absent; **granules** globose, 100–400 µm, initially ecorticate but soon developing a thick pseudocortex, well organized and discrete before becoming incorporated into the hypothallus, not forming compound units, sometimes separating from the hypothallus; **photobiont** green, coccoid, cells globose, 6–10 µm.

Chemistry. – Chemotype 1 (*L. xerophila* s. str.): atranorin, pannaric 6-methylester, roccellic/angardianic acid and/or rangiformic/jackinic acid; spot tests: K+ yellowish, C-, KC-, P+ yellowish, UV-. Chemotype 2 (*L. xerophila*): atranorin, norascomatic acid; spot tests: K+ yellowish, C-, KC-, P+ yellowish, UV-.

For a more detailed explanation of the compounds produced by *Lepraria xerophila* the reader should refer to Elix and Tønsberg (2004).

Ecology and distribution. – In North America *Lepraria xerophila* is restricted to soil communities in coastal habitats along the Pacific Ocean from southern California to southern Baja California in Mexico (figure 61).

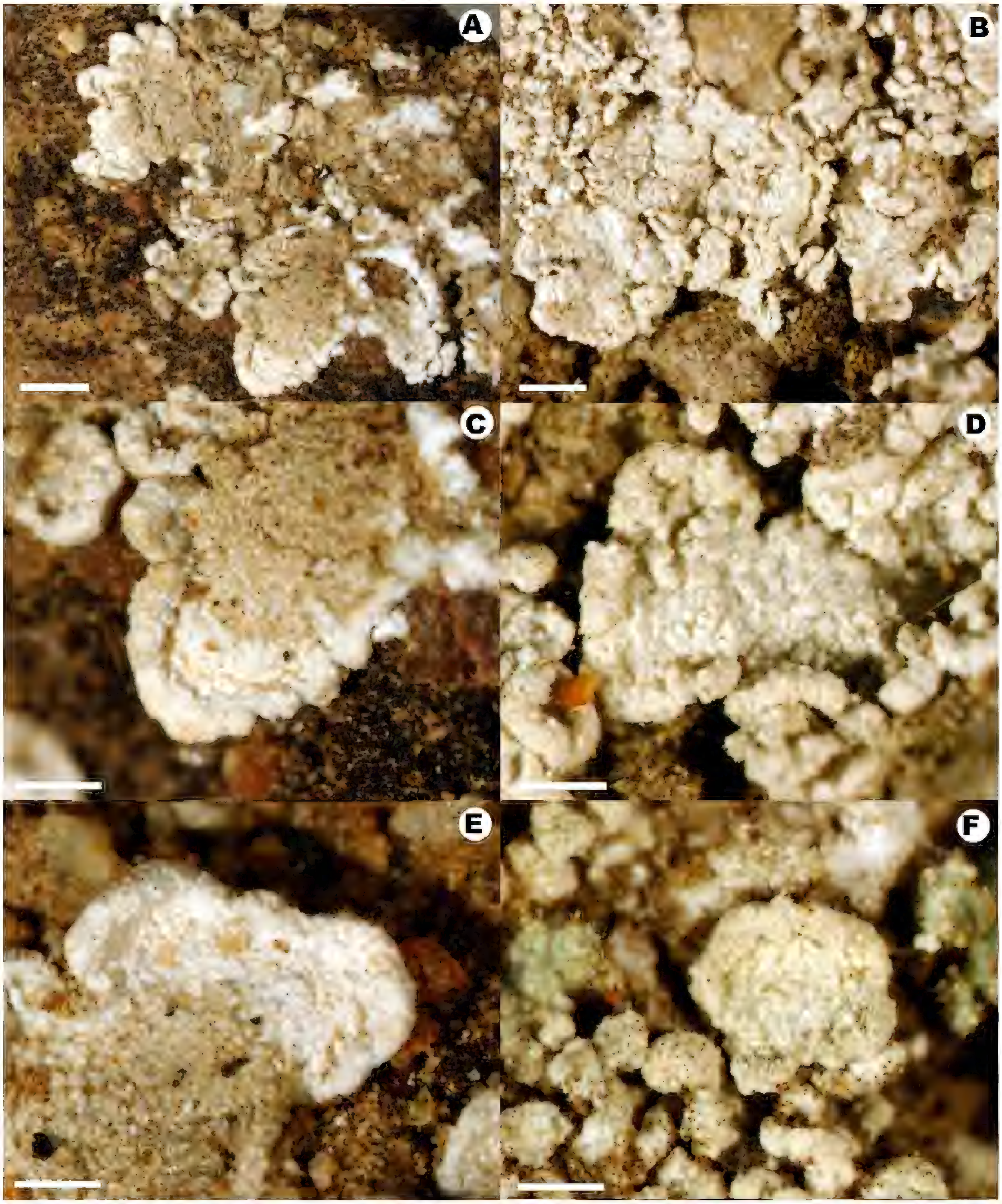

Figure 60, Comparison of the typical chemotype of *Lepraria xerophila* (left, *Bratt 5636*) and the chemotype that produces norascomatic acid (right, *Knudsen 7624*). A–B, gross morphology of the thallus (scales = 1.0 mm). C–E, detail of the thallus margins (scales = 0.5 mm). F, young thallus and large aggregations (scale = 0.5 mm).

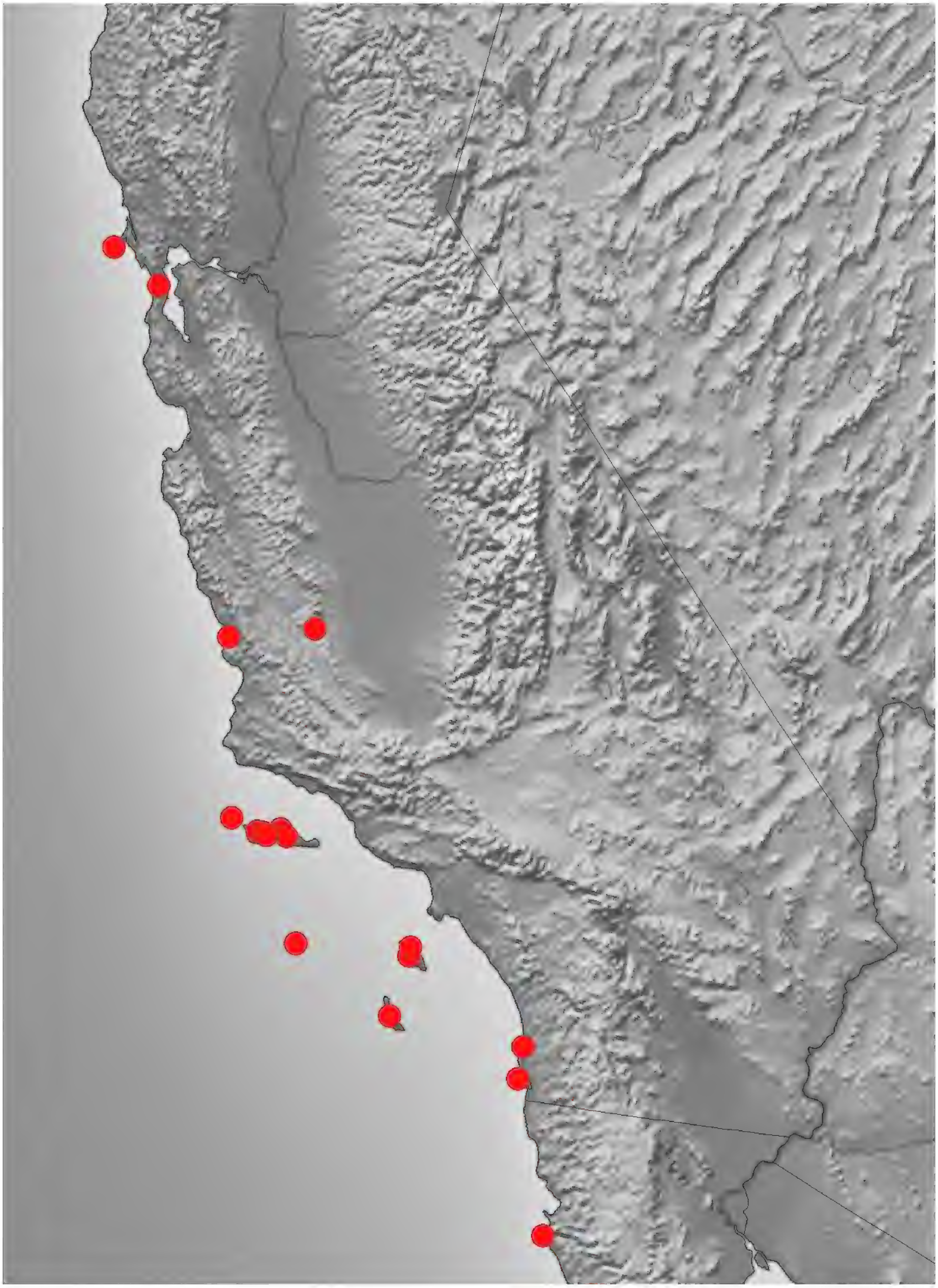

Figure 61, geographic distribution of *Lepraria xerophila* based on the specimens examined for this study.

Conservation status. – Based on the distribution map presented by Tønsberg (2004) this species appears to be common along the Pacific Coast in Baja California, Mexico. However, these collections are based on a sampling period of decades and it not possible to determine the current status of soil communities there. In the study area (i.e., the United States), the species is locally abundant in coastal soil communities. However, these communities have been heavily impacted by anthropogenic change and many of the endemic species in them have become rare (Knudsen 2009, 2010).

Discussion. – *Lepraria xerophila* belongs to a distinct group of morphologically defined species with *xerophila*-type placodioid thalli that occur on soil and organic matter in Mediterranean habitats throughout the world. No other members of this group occur in North America, and thus *L. xerophila* is not likely to be confused with any of its congeners in the study area with the exception of *L. vouauxii*. That species is chemically similar in the production of pannaric acid 6-methylester, however, it differs in having a *finkii*-type placodioid thallus and in typically occurring in sheltered microhabitats rather than in sheltered soil communities.

Selected specimens examined (35 total seen from North America; chemotype 1). – **U.S.A. CALIFORNIA.** LOS ANGELES CO.: Santa Catalina Island, headland between Cottonwood Canyon and Mills Landing, 5.iv.1966, on soil, *W.A. Weber & R. Santesson [L-42780]* (COLO). ORANGE CO.: Santa Ana Mountains, Weir Canyon, N/S of Windy Ridge Rd., 17.v.2006, on soil, *K. Knudsen 6111* (NY). SAN DIEGO CO.: Cabrillo National Monument, above 2nd parking lot, 13.i.1988, on soil, *C. Bratt 5636 & B.D. Ryan* (NY); Torry Pines [State Park], 9.vi.1926, on soil, *G.E. DuRietz & G. DuRietz N:p214:1* (COLO). SAN FRANCISCO CO.: San Francsico Presidio, 31.vii.2010, on rock, *S. Benson 74* (NY). SAN LUIS OBISPO CO.: Morro Rock Reserve, 10.xi.1987, on moss and soil, *R.E. Riefner 87-471* (COLO). SANTA BARBARA CO.: Santa Rosa Island, Soledad Grove, SE of Main Rd., 19.x.2006, on soil, *K. Knudsen et al. 7778* (NY). VENTURA CO.: San Nicholas Island, along S canyon wall of Celery Creek, 6-7.iv.1966, on rock, *R. Foreman s.n.* (COLO).

Specimen examined (chemotype 2). – **U.S.A. CALIFORNIA.** SANTA BARBARA CO.: Santa Rosa Island, lower Water Canyon, near road, 16.x.2006, on soil, *K. Knudsen 7624* (NY).

Excluded and doubtful taxa

This section outlines the disposition of the species that either do not belong to *Lepraria* s. str., or do not occur in North America. It will be noticed that some species excluded from *Lepraria* s. str. here are, nonetheless, retained in the genus. This is due to the fact that molecular data are needed to determine, or confirm, their higher level taxonomic placement (Hodkinson & Lendemer 2012; Lendemer & Hodkinson 2013). In the absence of well-supported results from molecular phylogenetic analyses of these data, I strongly advocate the retention of these species within *Lepraria* with the recognition that they belong to the genus in its historical (i.e., non-monophyletic) sense. The continued existence of a two-tiered taxonomy within *Lepraria* is clearly not ideal from the standpoint of evolutionary biology. It is nonetheless an efficient pragmatic solution that allows the continued description of leprarioid species so that they can enter the taxonomic dialogue and be evaluated by other workers.

Lepraria adhaerens K. Knudsen, Lendemer & Elix

As per Lendemer and Hodkinson (2013) this species should be treated as *Leprocaulon adhaerens* (K. Knudsen, Lendemer & Elix) Lendemer & Hodkinson.

Lepraria barbatica Lendemer

This is a rare species with a leprarioid crustose thallus that clearly does not belong to *Lepraria* s. str. based on its production of usnic acid and barbatic acid. Its true phylogenetic affinities remain unresolved at present. *Lepraria barbatica* was known only from the type specimen, however a second population was found during fieldwork in the Ozark Ecoregion, it is cited below.

Specimen examined. – **U.S.A. ARKANSAS.** CLEBURNE CO.: N portion of North Unit of Big Creek Natural Area, ~1.5 mi due E of Wilburn, 9.x.2010, on rock in overhang, *J.C. Lendemer 26372 & D. Ladd* (NY).

Lepraria crassissima (Hue) Lettau

As has been discussed in detail by Lendemer (2011c) this species is not present in North America.

Lepraria crassissima var. *isidiata* Llimona

This taxon is now recognized as a species, *L. isidiata* (Llimona) Llimona & A. Crespo, and occurs in Mediterranean regions of Europe. It belongs to the distinctive group of species with *xerophila*-type placodioid thalli that occur in such habitats. The species does not occur in North America and all previous reports represent misidentifications of other species (e.g., *L. nivalis*, *L. normandinoides*, or *L. oxybapha*).

Lepraria disjuncta Lendemer

This is an infrequent species that is widespread on calcareous rocks throughout eastern North America. Based on the production of usnic acid, zeorin, and xanthones in this species it clearly does not belong to *Lepraria* s. str. Its true phylogenetic position is uncertain at this time.

Lepraria incana (L.) Ach.

As has been discussed in detail by Lendemer (2011c) this species is not present in North America.

Lepraria lobificans Nyl.

The status of this name has been resolved in the section for *Lepraria finkii* above. The species is not present in North America.

Lepraria moroziana Lendemer

This is a rare species endemic to the spruce-fir forests of the Appalachian Mountains of eastern North America. It is not infrequent at high elevations of the southern Appalachian Mountains and occurs as far north as New Brunswick, Canada. Based on the production of isousnic acid and obtusatic acid in this species it clearly is not a member of *Lepraria* s. str. The true phylogenetic position of this taxon is uncertain at this time.

Lepraria santamonicae K. Knudsen & Elix

As per Lendemer and Hodkinson (2013) this species should be treated as *Leprocaulon santamonicae* (K. Knudsen & Elix) Lendemer & Hodkinson.

Lepraria terricola Lendemer

As per Lendemer and Hodkinson (2013) this species should be treated as *Leprocaulon terricola* (Lendemer) Lendemer & Hodkinson.

Lepraria texta K. Knudsen, Elix & Lendemer

As per Lendemer and Hodkinson (2013) this species should be treated as *Leprocaulon texta* (K. Knudsen, Elix & Lendemer) Lendemer & Hodkinson.

Lepraria xanthonica Lendemer

This is an infrequent species that is widely distributed in eastern North America. It is characterized by the presence of usnic acid, zeorin, and 5,7-dichloro-3-*O*-methylnorlichexanthone and thus clearly does not belong to *Lepraria* s.str. The true phylogenetic affinities of this taxon remain unresolved at the present time.

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Appendix A – Tabular summary of tallus types

	primary thallus type	thallus subtype
aurescens	placodioid	*cryophila*-type
caesiella	aggregate	*caesiella*-type
cryophila	placodioid	*cryophila*-type
diffusa	aggregate	*caesiella*-type
eburnea	placodioid	*finkii*-type
elobata	aggregate	*caesiella*-type
finkii	placodioid	*finkii*-type
friabilis	aggregate	*caesiella*-type
harrisiana	placodioid	*finkii*-type
hodkinsoniana	aggregate	*caesiella*-type
humida	aggregate	*caesiella*-type
jackii	aggregate	*caesiella*-type
lanata	aggregate	lanta-type
lecanorica	aggregate	caesioalba-type
leprolomopsis	placodioid	finkii-type
membranacea	placodioid	finkii-type
neglecta	aggregate	caesioalba-type
nivalis	placodioid	finkii-type
normandinoides	placodioid	*normandinoides*-type
oxybapha	placodioid	*normandinoides*-type
pacifica	aggregate	*caesiella*-type
rigidula	aggregate	*caesiella*-type
squamatica	placodioid	*cryophila*-type
torii	aggregate	*caesiella*-type
vouauxii	placodioid	*finkii*-type
xerophila	placodioid	*xerophila*-type

Table 1. Listing of thallus types of the North American species of *Lepraria* s. str. following the descriptive scheme outlined by Lendemer (2011a).

Appendix B – Tabular summary of measurements of morphological structures

	granules	hyphae	photobiont
aurescens	[26]–(36)–45–(54) –[72] µm (n=126)	[1.6]–(2.3)–2.8–(3.4)–[4.8] µm (n=64)	[6.0]–(7.5)–9.2–(10.8)–[14.6] µm (n=135)
caesiella	[24]-(35)-47-(59)-[76] µm (n=96)	[1.8]-(2.4)-3.1-(3.7)-[5.0] µm (n=42)	[6.0]-(7.9)-9.8-(11.8)-[15.6] µm (n=96)
cryophila	[18]-(24)-30-(37)-[52] µm (n=120)	[1.4]-(2.2)-2.8-(3.4)-[5.0] µm (n=120)	[5.0]-(6.3)-8.0-(9.6)-[12.5] µm (n=120)
diffusa	[26]-(40)-62-(84)-[132] µm (n=32)	[1.4]-(1.9)-2.4-(2.9)-[3.3] µm (n=32)	[6.0]-(7.2)-9.2-(11.1)-[13.2] µm (n=32)
eburnea	[22]-(33)-51-(68)-[114] µm (n=97)	[1.6]-(2.3)-2.9-(3.6)-[4.5] µm (n=100)	[5.4]-(7.4)-9.3-(11.4)-[14.4] µm (n=97)
elobata	[18]-(27)-35-(42)-[62] µm (n=155)	[1.4]-(2.3)-2.9-(3.6)-[4.8] µm (n=96)	[4.8]-(7.0)-9.0-(11.0)-[16.8] µm (n=96)
finkii	[24]-(33)-48-(63)-[104] µm (n=166)	[2.4]-(2.6)-3.1-(3.6)-[4.8] µm (n=107)	[4.8]-(6.8)-9.1-(11.3)-[15.6] µm (n=97)
friabilis	[24]-(32)-42-(52)-[66] µm (n=128)	[1.5]-(2.2)-2.8-(3.4)-[4.3] µm (n=96)	[4.8]-(6.9)-8.9-(11.0)-[15.6] µm (n=90)
harrisiana	[19]–(27)–38–(48) –[72] µm (n=124)	[1.2]–(2.2)–2.9–(3.5)–[4.8] µm (n=68)	[6.0]–(7.8)–9.6–(11.4)–[14.4] µm (n=97)
hodkinsoniana	[15]-(25)-33-41-[60] µm (n=180)	[1.7]-(2.3)-3.0-(3.8)-[7.0] µm (n=180)	[5.0]-(6.8)-8.8-(10.9)-[16.0] µm (n=180)
humida	[18]-(27)-36-(46)-[72] µm (n=93)	[1.4]-(1.9)-2.6-(3.3)-[3.7] µm (n=43)	[5.7]-(6.9)-8.8-(10.7)-[13.8] µm (n=103)
jackii	[14]-(23)-30-(38)-[54] µm (n=125)	[1.4]-(2.3)-2.9-(3.4)-[4.2] µm (n=96)	[4.8]-(6.7)-8.9-(11.1)-[14.4] µm (n=101)
lanata	[28]-(40)-57-(74)-[102] µm (n=32)	[2.6]-(3.7)-5.7-(7.4)-[9.6] µm (n=32)	[6.0]-(7.4)-8.6-(9.8)-[11.0] µm (n=32)
lecanorica	[42]-(51)-81-(111)-[156] µm (n=32)	[1.5]-(2.1)-2.6-(3.1)-[3.6] µm (n=32)	[6.0]-(7.3)-10.0-(12.7)-[15.9] µm (n=32)
leprolomopsis	(25)-30-40-(45) µm	(3.0)-3.5-4.0 µm	8.0-13.0 µm
membranacea	[24]-(27)-41-(54)-[90] µm (n=90)	[1.4]-(2.0)-3.2-(3.6)-[4.8] µm (n=97)	[6.0]-(7.1)-9.4-(11.8)-[15.6] µm (n=96)
neglecta	[30]-(42)-59-(77)-[102] µm (n=131)	[1.8]-(2.3)-2.9-(3.4)-[4.8] µm (n=96)	[4.8]-(7.2)-9.4-(11.7)-[15.6] µm (n=96)
nivalis	[19]-(29)-43-(58)-[74] µm (n=65)	[1.4]-(1.9)-2.4-(3.0)-[4.2] µm (n=65)	[6.0]-(6.8)-8.7-(10.6)-[13.2] µm (n=65)
normandinoides	[19]-(24)-38-(53)-[84] µm (n=52)	[1.8]-(2.3)-2.9-(3.7)-[4.8] µm (n=58)	[6.0]-(7.9)-9.8-(11.6)-[13.2] µm (n=72)
oxybapha	[24]-(35)-48-(61)-[80] µm (n=45)	[2.1]-(2.6)-3.3-(4.0)-[4.8] µm (n=39)	[5.0]-(7.7)-9.6-(11.5)-[13.2] µm (n=39)
pacifica	[16]-(24)-32-(40)-[60] µm (n=120)	[1.7]-(2.2)-2.8-(3.3)-[4.0] µm (n=120)	[5.0]-(6.1)-7.5-(8.9)-[13.0] µm (n=120)
rigidula	[24]-(30)-43-(55)-[78] µm (n=96)	[2.1]-(2.5)-3.1-(3.6)-[5.2] µm (n=64)	[6.0]-(7.7)-9.7-(11.8)-[13.3] µm (n=64)
squamatica	[22]–(29)–42–(54) –[80] µm (n=132)	[1.5]–(2.2)–2.7–(3.2)–[4.0] µm (n=66)	[5.6]–(6.9)–8.8–(10.7)–[14.4] µm (n=66)
torii	[19]-(28)-37-(46)-[62] µm (n=133)	[1.8]-(2.2)-2.7-(3.1)-[4.5] µm (n=64)	[5]-(6.2)-8.1-(9.9)-[13.2] µm (n=64)
vouauxii	[24]-(32)-47-(61)-[90] µm (n=97)	[1.4]-(2.1)-2.7-(3.3)-[4.2] µm (n=97)	[4.8]-(6.3)-8.9-(11.5)-[18] µm (n=97)
xerophila	100-400 µm	4-6 µm	6-10 µm

Table 2. Tabular comparison of granule size, hyphal width, and photobiont cell diameter in the species of *Lepraria* s. str. treated here. (All data are excerpted from the descriptions below.)

Appendix C – Graphical summaries of measurements of hyphal width

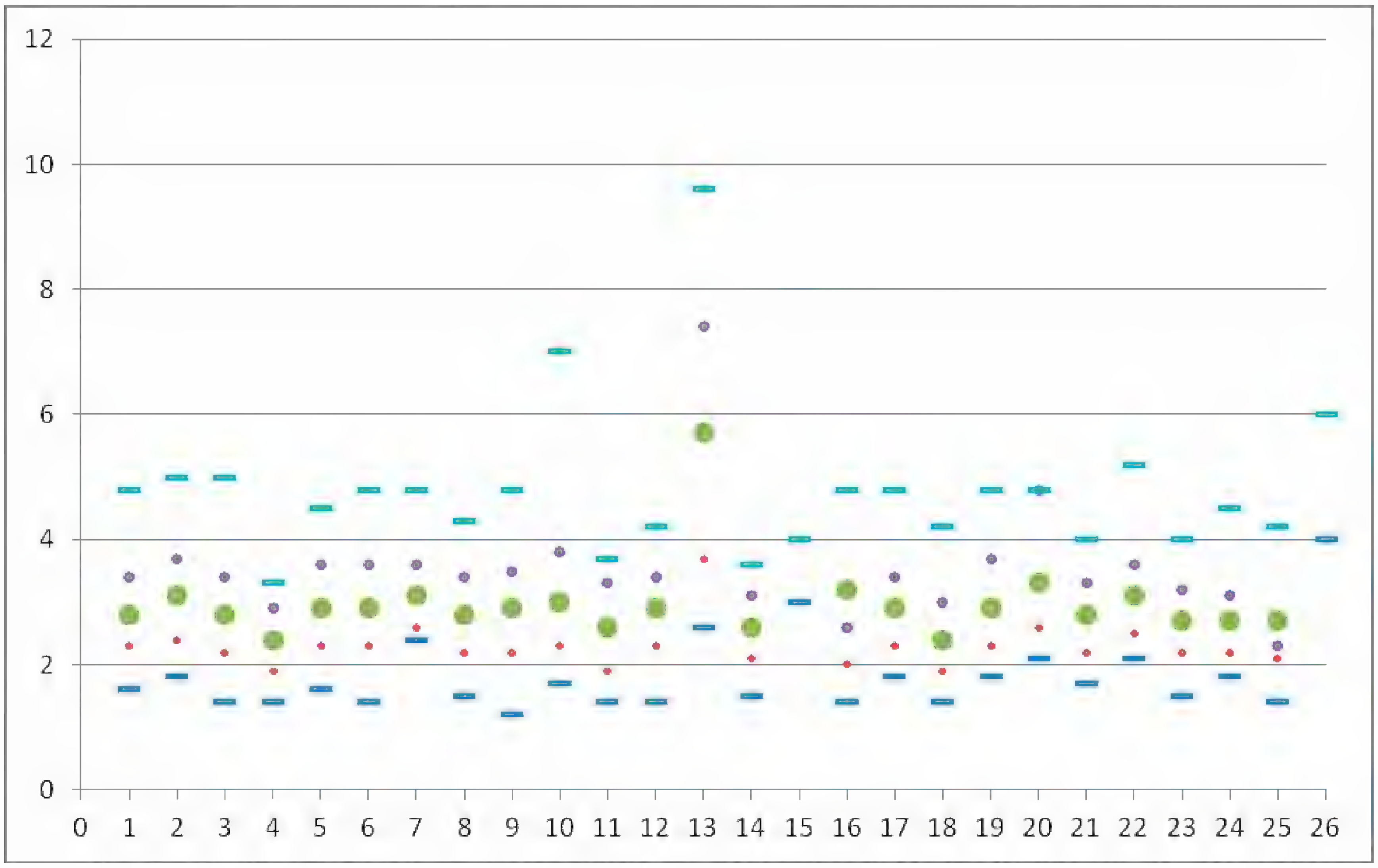

Figure 61, graphical representation of variability in hyphal width between species of *Lepraria* treated here. Numbers on the x-axis correspond to the species accounts herein, the y-axis refers to µm. Numerical ranges are illustrated as the average (large dot) +/- 1 standard deviation (small dots) and bounded by the extreme values observed (bars). Note that as is the case for the descriptions of *L. leprolomopsis* (15) and *L. xerophila* (26) only the range of observed values is shown.

Appendix D – Graphical summaries of measurements of granule size

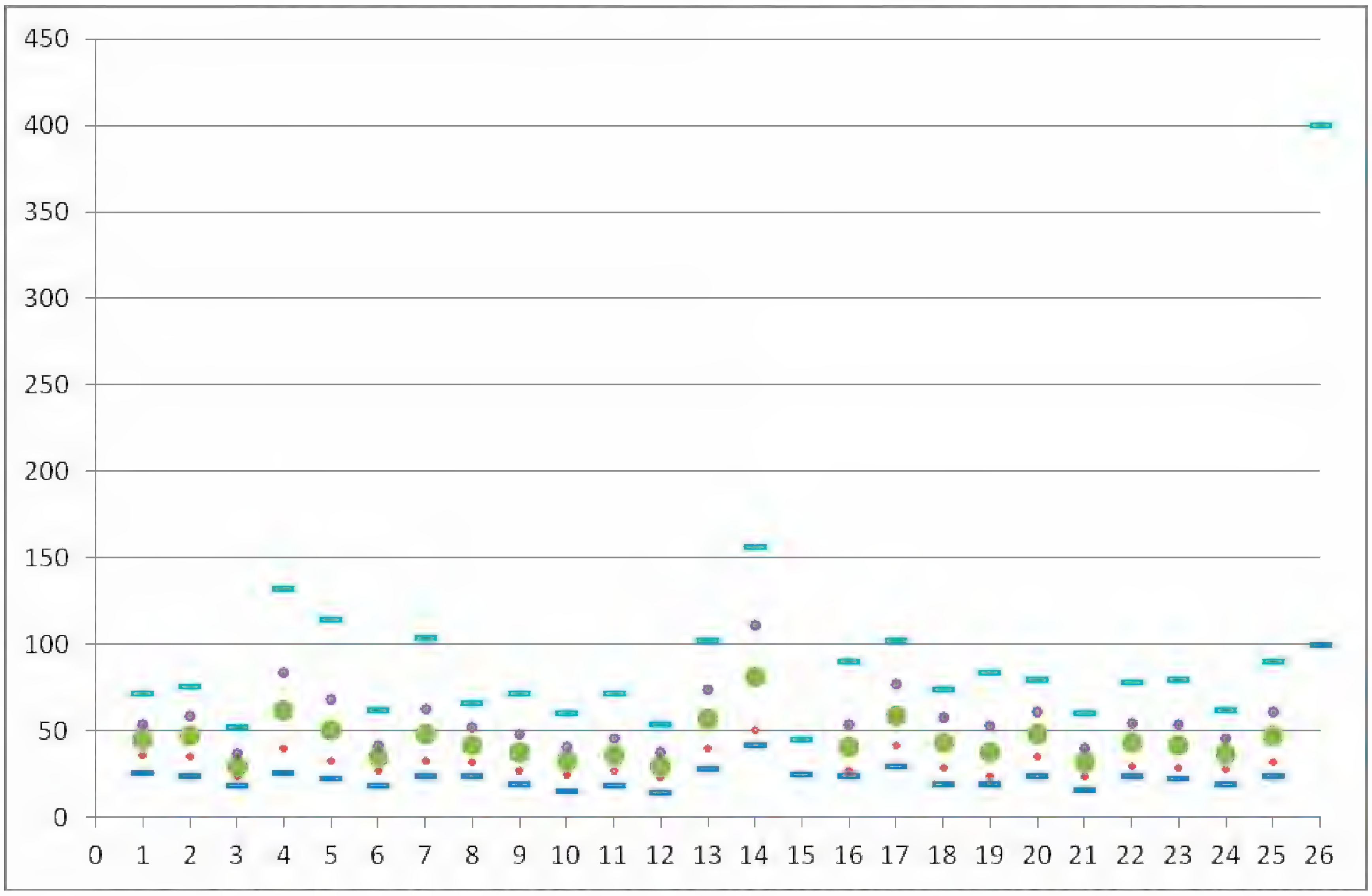

Figure 62, graphical representation of variability in granule size between species of *Lepraria* treated here. Numbers on the x-axis correspond to the species accounts herein, the y-axis refers to µm. Numerical ranges are illustrated as the average (large dot) +/- 1 standard deviation (small dots) and bounded by the extreme values observed (bars). Note that as is the case for the descriptions of *L. leprolomopsis* (15) and *L. xerophila* (26) only the range of observed values is shown.

Appendix E – Graphical summaries of measurements of photobiont cell diameter

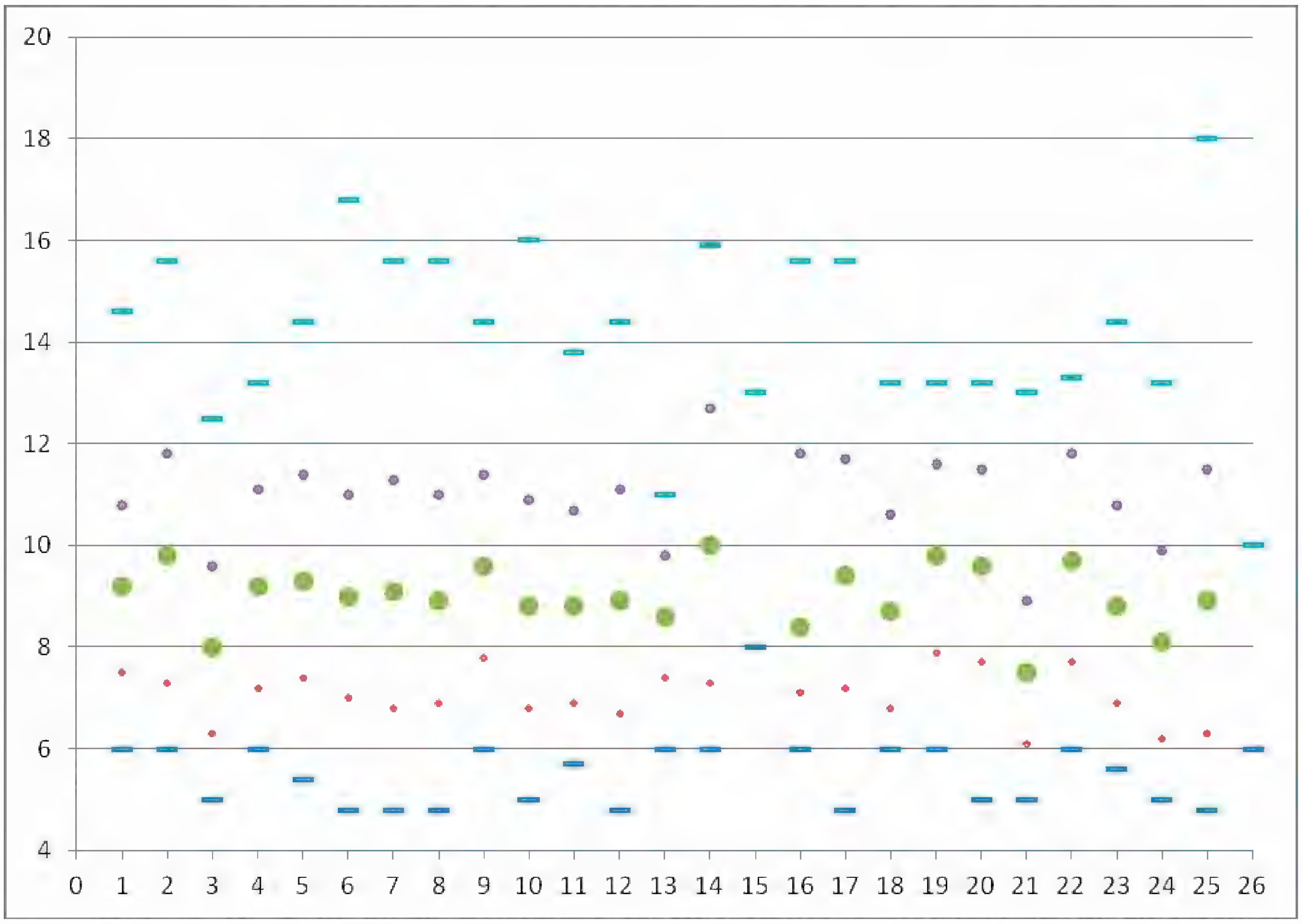

Figure 63, graphical representation of variability in photobiont cell diameter between species of *Lepraria* treated here. Numbers on the x-axis correspond to the species accounts herein, the y-axis refers to µm. Numerical ranges are illustrated as the average (large dot) +/- 1 standard deviation (small dots) and bounded by the extreme values observed (bars). Note that as is the case for the descriptions of *L. leprolomopsis* (15) and *L. xerophila* (26) only the range of observed values is shown.

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A first checklist of lichenicolous fungi from the Dominican Republic, including the description of a new species of *Xenonectriella*

JAVIER ETAYO[1] & PIETER VAN DEN BOOM[2]

ABSTRACT. – The first checklist of lichenicolous fungi for the Dominican Republic is presented. The annotated list includes a total of 24 taxa, 15 of which are reported for the first time from the region and one (*Xenonectriella dirinariae* on *Dirinaria* sp.) that is described as new to science.

KEYWORDS. – Taxonomy, lichens, West Indies, Caribbean, new records, biodiversity.

INTRODUCTION

To date lichenicolous fungi have rarely been reported from the Dominican Republic. Indeed, during a review of the literature we found only eight such reports (Diederich 1996, Diederich 2003, Diederich et al. 2009, Etayo 2002, Tibell 1996, Vainio 1896). These reports are included in the annotated list below. In general, lichenicolous fungi have rarely been reported from the West Indies, excepting those ocurring on foliicolous lichens (Matzer 1996) or those occuring on members of the Caliciales, studied by Tibell (1996). Other recent reports are only isolated and dispersed in the literature, such as *Tremella harrisii* Diederich (Diederich 1996) and *Endococcus apiciicola* (J. Steiner) R. Sant. (Diederich 2003), both reported from Puerto Rico.

The same is true for Central America, although many studies on lichens are known, especially from Costa Rica as result of the Ticolichen project by Robert Lücking and co-workers. We know of only two papers on lichens and lichenicolous fungi from Panama, one with seven lichenicolous fungi reported from epiphilous lichens (Etayo 1997) and another in which a report of 67 epiphytic taxa and four lichenicolous fungi is given (Etayo & Aptroot 2005). Furthermore there exists just one paper exclusively on lichenicolous fungi from Guatemala (Etayo & van den Boom 2006). In that contribution 23 species were treated and one species newly described.

The Dominican Republic is a part of the West Indies (Greater Antilles) and is situated in the Caribbean. Together with Haiti, it forms the Island of Hispaniola (the eastern part) and is 48,442 km^2 in size. The Caribbean Sea is found at the southern side of the island and the northern side is bordered by the Atlantic Ocean. Pico Duarte is the highest point of the mountain range 'the Cordillera Central' reaching 3185 meters in altitude. The island has a tropical climate with annual temperatures between 28 and 33°C.

Early in 2008, the second author and his wife visited the northern part of the country with the aim of collecting lichens and lichenicolous fungi. This trip, which focused primarily on habitats in and surrounding urbanized areas, resulted in the discovery of sixteen species of lichenicolous fungi that had not previously been reported from the region. Here we present these reports, together with a summary of the species previously reported from the country.

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[1] JAVIER ETAYO – Navarro Villoslada 16, 3° dcha., E-31003 Pamplona, Navarra, Spain. – e-mail: jetayosa@educacion.navarra.es

[2] PIETER VAN DEN BOOM – Arafura 16, 5691 JA, Son, the Netherlands. – e-mail: pvdboom@kpnmail.nl

MATERIALS AND METHODS

This study is based primarily on specimens collected by the second author (PvdB) and deposited in his private herbarium (hb. van den Boom) with some duplicates deposited in B. Additionally, type material of the new species is deposited in BR and the private herbarium of the first author (JE; hb. Etayo). All specimens have been studied by conventional macro- and microscopical techniques with hand-cut sections of the material mounted in water. Spore sizes were measured in water. All localities are provided with geographical coordinates based on GPS.

ANNOTATED CHECKLIST

***Abrothallus hypotrachynae* Etayo & Diederich**

NOTES. – Recorded on *Hypotrachyna endochlora* from La Vega (Etayo 2002).

***Abrothallus parmotrematis* Diederich**

NOTES. – This species was formally described by Diederich (2011) where it was reported from Europe, Macaronesia and North America (U.S.A.). This is the first report for both the Dominican Republic and the West Indies. In our specimen the ascospores are brownish, 1-septate, 13–16 × 5.5–6 µm and it was found growing directly on the thallus of the host. Typical hosts for this taxon are *Parmotrema* species.

Specimen examined. – **DOMINICAN REPUBLIC. SANTIAGO PROV.:** NE of Santiago de los Caballeros, La Cumbre, just N of the village, NW slope with banana plantation with scattered trees and fence posts, 19°32'N, 70°36'W, 770 m, on *Parmotrema reticulatum*, 3.i.2008, *P. & B. van den Boom 39446* (hb. van den Boom).

***Buelliella minimula* (Tuck.) Fink ex Hafellner**

NOTES. – This species has been reported from North America (U.S.A.; Hafellner 1979), Central America (Mexico; Hafellner 1979), South America (Ecuador; Diederich 2003) as well as from Europe (Sweden; Santesson et al. 2004). This is the first report for the Dominican Republic and the West Indies. In our specimen, we found hyaline (young) to pale brown (old) ascospores that are 12.5–15 × 5.5–6.5 µm in size. It is only known from species of *Pertusaria*, where it occurs on the thallus like in our sample.

Specimen examined. – **DOMINICAN REPUBLIC. SANTIAGO PROV.:** NE of Santiago de los Caballeros, La Cumbre, just N of the village, NW slope with banana plantation with scattered trees and fence posts, 19°32'N, 70°36'W, 770 m, on *Pertusaria* sp. on fallen branch, 3.ii.2008, *P. & B. van den Boom 39466* (B, hb. van den Boom).

***Capronia peltigerae* D. Hawksw.**

NOTES. – Previously this species has been reported from North America (Alaska, U.S.A.; Zhurbenko & Laursen 2003). This is the first report of the species from both the Dominican Republic and the West Indies. In our specimen, the ascospores are 3-septate, hyaline and approximately 15 × 5 µm in size. It was found growing on the thallus of the host and is known from different *Peltigera* species (Diederich & Sérusiaux 2000).

Specimen examined. – **DOMINICAN REPUBLIC. SANTIAGO PROV.:** SW of Santiago de los Caballeros, S of San José de las Matas, unpaved road (to Mata Grande), just S of Los Montones, coffee plantation with some scattered rather high trees, 19°14'N, 70°55'W, 800 m, 31.i.2008, on *Peltigera* sp. on vertical facing soil, *P. & B. van den Boom 39177* (hb. van den Boom).

Chaenothecopsis pusilla (Ach.) A.F.W. Schmidt

NOTES. – This species was reported by Tibell (1996) from La Vega, although it was not indicated whether the sample had a lichenicolous habit.

Chaenothecopsis savonica (Räsänen) Tibell

NOTES. – This species was reported by Tibell (1996) from La Vega, although it was not indicated if the sample had a lichenicolous habit.

***Keratosphaera dimerellae* Matzer**

NOTES. – This species was described by Matzer (1996) from Costa Rica. This is the first report of the species from the Dominican Republic and the West Indies. Our specimen has hyaline conidia, 12–14 × 2.3–2.5 µm in size and it was found growing on the thallus of *Coenogonium*.

Specimens examined. – **DOMINICAN REPUBLIC. DUARTE PROV.:** NE of San Francisco de Macorís, SSE slope of Loma Quita Espuela, starting point at 'Rancho Don Lulu', trail in cocoa plantation with some mature unidentified trees, 19°20'N, 70°08'W, 400 m, on *Coenogonium subluteum* on cocoa leaf, 4.ii.2008, *P. & B. van den Boom 39396, 39400* (hb. van den Boom); *P. & B. van den Boom 39404* (B, hb. van den Boom).

***Lichenochora galligena* R. Sant. & Hafellner**

NOTES. – Previously this taxon was known from Africa (Tanzania; Hafellner 1989), South America (Paraguay; Hafellner 1989), and North America (U.S.A.; Diederich 2003). This is the first report of the species from both the Dominican Republic and the West Indies. This species is distinguished from other members of the genus by an infection that induces the formation of galls on thalli of the genus *Physcia* and in having verruculose ascospores with two equally sized cells. Our specimen fits the circumscription of *Lichenochora galligena* well, but the ascospores are slightly larger (11–14 × 7–8.5 µm (*n*=10) *vs.* 9–11 × 6–8 µm).

Specimen examined. – **DOMINICAN REPUBLIC. ESPAILLAT PROV.:** E of Puerto Plata, Río San Juan, just near village, Laguna Gri Gri, mangrove (swamp) along forest with palm trees and unidentified small trees, 19°38'N, 70°04'W, 1 m, on *Physcia* sp. on mangrove, 1.ii.2008, *P. & B. van den Boom 39249* (hb. van den Boom).

***Lichenoconium xanthoriae* M.S. Christ.**

NOTES. – This species is widely distributed in Europe and also known from Africa and America (Etayo 2002, Kocourková 2000, Triebel et al. 1991). This is the first report of the species from both the Dominican Republic and the West Indies. Our specimen grew abundantly on both the apothecia (mainly) and podetia of the host (*Cladonia*). It matches well the description published by Christiansen (1956). We found sessile pycnidia 70–150 µm in diameter with a brown wall, conidiogenous cells of 8–10 × 2.5–3 µm and brown conidia, 3–4 µm in diameter. Species of *Lichenoconium* can live on several different hosts.

This species is usually found on *Xanthoria parietina* and *X. polycarpa*. However other host genera such as *Caloplaca, Cetrelia, Melanelia, Teloschistes* and *Tuckermannopsis* are known (Kocourková 2000). It was reported from *Cladonia* before only by Zhurbenko and Alstrup (2004). Four other known *Lichenoconium* species have also been reported from *Cladonia* and should be compared with *L. xanthoriae*. The recently described *L. aeruginosum* Diederich, M. Brand, van den Boom & Lawrey is distinguished by the pigments in the pycnidial wall, which is hyaline to pale brown in the lower part and bluish grey in the upper part, it gives a strong aeruginose reaction in KOH of the lateral and upper pycnidial wall (Lawrey et al. 2011). *Lichenoconium pyxidatae* (Oudem.) Petrak & H. Sydow grows on the podetia and basal squamules of the host (not the apothecia as in our specimen), the conidiogenous cells are smaller (6–9 × 1.5–2.5 µm), and the conidia are different, shortly ellipsoid, distinctly truncate and 2.5–3.5 × 2–3 µm (Diederich 2004). *Lichenoconium erodens* M.S. Christ. & D. Hawksw. and *L. usneae* (Anzi) D. Hawksw. have distinctly smaller pycnidia (30–50 and 50–80 µm respectively), which are mainly immersed, as well as different conidia (2–3.5 µm in the former and verruculose in the latter) (Diederich 2004).

Specimen examined. – **DOMINICAN REPUBLIC. DUARTE PROV.:** NE of San Francisco de Macorís, SSE slope of Loma Quita Espuela, starting point at 'Rancho Don Lulu', trail among open fields with fence trees and fence posts, 19°20'N, 70°08'W, 490 m, 4.ii.2008, on *Cladonia* on soil, *P. & B. van den Boom 39518* (B, hb. van den Boom).

***Lichenopeltella heterodermiicola* M.S. Cole & D. Hawksw.**

NOTES. – This species was described from North America (U.S.A.; Cole & Hawksworth 2002) and subsequently reported from South America (Ecuador; Diederich 2003). Here we report the species for the first time from the Dominican Republic and the West Indies. In our specimen we have found ascomata ca. 0.15 mm in diameter and hyaline ascospores, 13–15 × 4–5 µm in size.

Specimen examined. – **DOMINICAN REPUBLIC. SANTIAGO PROV.:** SW of Santiago de los Caballeros, S of San José de las Matas, unpaved road c. 1 km S of Los Monotones, roadside trees near village, 19°13'N, 70°55'W, 830 m, on *Heterodermia albicans* on a mature tree, 31.i.2008, *P. & B. van den Boom 39202* (B, hb. van den Boom).

***Lichenostigma cosmopolites* Hafellner & Calat.**

NOTES. – Reported on *Xanthoparmelia* cf. *cumberlandia* from Alto de la Bandera by Diederich (2003).

***Llimoniella pyrenulae* Diederich & Etayo**

NOTES. – Reported on *Pyrenula quassiaecola* from La Vega by Diederich et al. (2009).

***Muellerella hospitans* Stizenb.**

NOTES. – Previously *Muellerella hospitans* has been reported from several countries in Europe (Santesson et al. 2004), Asia (Russia; Zhurbenko & Santesson 1996), Macaronesia (Madeira; Hafellner 1995), North America (U.S.A.; Cole & Hawksworth 2001, Spribille et al. 2010), and South America (Peru; Etayo 2010). This is the first report of the species from the Dominican Republic and the West Indies. Our specimens of this taxon were found on an unidentified corticolous *Bacidia* and contain different types of ascospores. One specimen (*van den Boom 39524*) has many elliptical ascopores (3–4 × 2–2.5 µm in size) that are intermixed with ascospores that are sphaerical (2–2.5 µm in diameter). As the host (*Bacidia*) is the same genus as it is originally reported for *M. hospitans* by Stizenberger (1863), we believe that the name is appropriate for this specimen. The second specimen (*van den Boom 39462*) has sphaerical ascospores (2–2.5 µm in size) and is intermixed with some brownish conidiomata (30–60 µm in diameter) and elliptical conidiogenous cells, similar to those of *Lichenoconium*. *Muellerella hospitans* is known from several *Bacidia* species and from *Lecania fuscella* (Santesson et al. 2004).

Specimens examined. – **DOMINICAN REPUBLIC. SANTIAGO PROV.:** Santiago, NE of Santiago de los Caballeros, La Cumbre, just N of the village, NW slope with banana plantation with scattered trees and fence posts, 19°32'N, 70°36'W, 770 m, on *Bacidia* sp., on a fallen branch, 3.ii.2008, *P. & B. van den Boom 39462* (hb. van den Boom). **DUARTE PROV.:** NE of San Francisco de Macorís, SSE slope of Loma Quita Espuela, starting point at 'Rancho Don Lulu', trail among open fields with fence trees and fence posts, 19°20'N, 70°08'W, 490 m, on *Bacidia* sp., on an unidentified tree, 4.ii.2008, *P. & B. van den Boom 39524* (hb. van den Boom).

***Nectriopsis lecanodes* (Ces.) Diederich & Schoers**

NOTES. – This species has been reported from several macrolichen genera with cyanobacterial photobionts including mainly *Lobaria, Nephroma, Peltigera, Pseudocyphellaria*, but also *Collema, Degelia, Dendriscocaulon* and *Leptogium* and is known from Africa and America (Etayo & Diederich 1996, Kocourková 2000, Lawrey & Diederich 2011). This is the first report for the Dominican Republic and the West Indies. The Dominican material, which was found growing on *Coccocarpia* and *Leptogium*, differs in some respects from typical populations found on *Peltigera*. The material on *Coccocarpia* has perithecia 0.15–0.2 mm in diameter and ascospores 10–12 × 3.5–4.5 µm in size. The material on *Leptogium* has perithecia ca. 0.3 mm in diameter and ascospores 8–9 × 2.5–3 µm in size.

In the key published by Clauzade et al. (1989) the measurements for this species are: perithecia 0.2–0.3 mm, ascospores 9–12 × 3–4(–8) µm. The variability of this species, and the host selection has not been studied in detail, for this reason we include the Dominican records within the concept of *N. lecanodes* pending further studies.

Specimens examined. – **DOMINICAN REPUBLIC. SALCEDO PROV.:** NW of San Francisco de Macorís, W of road from Tenares to Gaspar Hernández, halfway to Los Cacaos, cocoa plantation from Altagracia Vargas, with small trees as fence post, 19°25'N, 70°21'W, 360 m, on *Leptogium* on cocoa, 30.i.2008, *P. & B. van den Boom 39146* (B, hb. van den Boom). **PUERTO PLATA PROV.:** S of Puerto Plata, Pico Isabel de Torre, botanical garden with damp and open forest with mixed trees and shrubs, 19°45'N, 70°42'W, 770 m, on *Coccocarpia* on *Spathodea campanulata*, 29.i.2008, *P. & B. van den Boom 39011* (hb. van den Boom).

***Nectriopsis lichenophila* (Speg.) Etayo**

NOTES. – A modern description of this species was published by Etayo (2002), where it was reported from South America (Brazil, Colombia). Later it was also reported from Bolivia (Flakus & Kukwa

2012). Here we report it for the first time from the Dominican Republic and the West Indies. It has hairy perithecia, ca. 0.2–0.25 mm in diameter and hyaline ascospores of 20–25 × 6.5–8 µm in size.

Specimen examined. – **DOMINICAN REPUBLIC. SANTIAGO PROV.:** SW of Santiago de los Caballeros, S of San José de las Matas, unpaved road c. 1 km S of Los Montones, roadside trees near village, 19°14'N, 70°55'W, 830 m, on *Heterodermia* on an unidentified mature tree, 31.i.2008, *P. & B. van den Boom 39207* (hb. van den Boom).

Nectriopsis peruvianus **Etayo & R. Sant.**

NOTES. – This interesting species was recently described by Etayo (2010) from Peru where it was found growing on both lichenized basidiomycetes (*Dictyonema*) and lichenized ascomycetes (*Coccocarpia*). This is the first report from the Dominican Republic and the West Indies. Another species occuring on *Coccocarpia* is *Nectriopsis coccocarpiae* Diederich (Aptroot et al. 1997), but that species has much smaller perithecia (0.03–0.04 mm) with a simpler wall that lacks external hairs, asci 29–31 × 11–12.5 µm in size and 1-septate hyaline ascospores measuring 10–11 × 3.5–4 µm. Our specimen has hairy perithecia, ca. 0.25 mm in diameter and 1-septate, hyaline ascospores that are 7–8 × 5.5–6 µm in size.

Specimen examined. – **DOMINICAN REPUBLIC. PUERTO PLATA PROV.:** S of Puerto Plata, Pico Isabel de Torres, botanical garden with damp and open forest with mixed trees and shrubs, 19°45'N, 70°42'W, 770 m, on *Coccocarpia* on a palm tree, 29.i.2008, *P. & B. van den Boom 39035* (B, hb. van den Boom).

Opegrapha foreaui **R. Sant. & Hafellner**

NOTES. – This species is widely distributed in tropical areas, including Puerto Rico in the West Indies (Diederich 2003). This is the first report of the species from the Dominican Republic. It occurs on *Heterodermia* and has elongate black apothecia with 3-septate hyaline ascospores (pale brown when very old) that are 14–16 × 4.5–5.5 µm in size.

Specimen examined. – **DOMINICAN REPUBLIC. PUERTO PLATA PROV.:** E of Puerto Plata, Cabarete, coastal area, center of village, parking place and garden, with mixed trees and some mature palm trees, 19°45'N, 70°24'W, 5 m, on *Heterodermia* on a palm tree, 27.i.2008, *P. & B. van den Boom 38942* (B, hb. van den Boom).

Opegrapha melanospila **Müll. Arg.**

NOTES. – Reported on *Parmotrema endosulphureum* from Samaná by Diederich (2003).

Ovicuculispora parmeliae **(Berk. et Curt.) Etayo**

NOTES. – The species is widely distributed worldwide and known from a wide range of host genera including *Erioderma*, *Graphis*, *Parmelia*, *Pertusaria*, and *Sticta* (Etayo 2010). All specimens cited here were found growing on species of the genus *Pyxine* and fit well the description based on specimens from *Heterodermia* that was published by Etayo (2010). This is the first report for the Dominican Republic and the West Indies. Our specimen has pale hairy apothecia, ca. 0.25 mm in diameter, hyaline ascospores of 40–45 × 20 µm, and microspores that are 8–10 × 5 µm in size.

Specimens examined. – **DOMINICAN REPUBLIC. PUERTO PLATA PROV.:** E of Puerto Plata, Cabarete, coastal area, center of village, parking place and garden, with mixed trees and some mature Palm trees, 19°45'N, 70°24'W, 5 m, on *Pyxine* sp. on a palm tree, 27.i.2008, *P. & B. van den Boom 38928* (B, hb. van den Boom). **SANTIAGO PROV.:** SW of Santiago de los Caballeros, S of San José de las Matas, unpaved road (to Mata Grande), just S of Los Monotones, coffee plantation with some scattered rather high trees, 19°14'N, 70°55'W, 800 m, on *Pyxine* sp. on an unidentified tree, 31.i.2008, *P. & B. van den Boom 39184* (hb. van den Boom). **ESPAILLAT PROV.:** E of Puerto Plata, Río San Juan, just near village, Laguna Gri Gri, mangrove (swamp) forest with palm trees and unidentified small trees, 19°14'N, 70°55'W, 1 m, on *Pyxine* sp. on a palm tree, 1.ii.2008, *P. & B. van den Boom 39269* (B, hb. van den Boom).

Sphinctrina tubaeformis A. Massal.

NOTES. – This species was reported by Tibell (1996) from La Vega as occuring on an unidentified *Pertusaria* species.

Tremella parmeliarum **Diederich**

NOTES. – Reported on *Parmotrema reticulatum* from La Vega by Diederich (2003).

Tubeufia heterodermiae **Etayo**

NOTES. – This species was described from northern Spain (Etayo 2002b) and seems to be widespread in Europe (Brackel 2010, Diederich et al. 2009, Eichler et al. 2010, van den Boom & van den Boom 2006, van den Boom & Palice 2006). This is the first report of the species from the Dominican Republic as well as the West Indies. Our specimen has pale hairy perithecia, 0.1–0.25 mm in diameter and multiseptate, hyaline, filiform ascospores, 80–90 × 2.5–3 µm. These measurements are somewhat different from those mentioned in the original description, 130–150 × 3–4 µm (Etayo 2002b), but in our opinion the species is more variable than previously thought.

Specimen examined. – **DOMINICAN REPUBLIC. SANTIAGO PROV.:** NE of Santiago de los Caballeros, La Cumbre, just N of the village, NW slope with banana plantation with scattered trees and fence posts, 19°32'N, 70°36'W, 770 m, on *Physcia* sp., 3.ii.2008, *P. & B. van den Boom 39425* (B, hb. van den Boom).

Xenonectriella dirinariae **Etayo & van den Boom sp. nov.**

Mycobank #805454.

FIGURE 1.

DIAGNOSIS. – Similar to *Xenonectriella leptalea*, but lichenicolous on *Dirinaria*, with smaller ascomata, 100–120 µm in diameter, and smaller ascospores, 9–10.5 × 4.5–5.5 µm, with a smooth wall.

TYPE: DOMINICAN REPUBLIC. ESPAILLAT PROV.: E of Puerto Plata, Río San Juan, just near village, Laguna Gri Gri, mangrove (swamp) forest with palm trees and unidentified small trees, 19°14'N, 70°55'W, 1 m, on *Dirinaria* sp. on mangrove, 1.i.2008, *P. & B. van den Boom 39248* (BR, holotype; hb Etayo, van den Boom, isotypes).

DESCRIPTION. – Ascomata (perithecia) dispersed, orange, subsphaerical to widely obpyriform, immersed, 100–120 µm diam., without hairs. Ascoma wall externally intensively yellow orange, K+ quickly violet-purple, without orange oil guttules, with more or less prismatic cells in the upper part and *textura epidermoidea* in the lower part, with irregularly enlarged cell walls, internally hyaline. Periphyses abundant around the ostiole, forming a vertical protruding cone, thin, ca. 1–1.5 µm thick. Paraphyses not observed in mature perithecia. Asci unitunicate, cylindrical, with obtuse apex, 8-spored, 35–43 × 5.5–8 µm (*n*=5). Ascospores uniseriately arranged inside the ascus, widely ellipsoid, 1-septate, not constricted at the septum, but with a torus around the septum, first hyaline, becoming golden to pale brown, with a smooth wall, without a perispore, 9–10.5 × 4.5–5.5 µm (*n*=20).

ECOLOGY AND DISTRIBUTION. – Despite extensive studies on lichenicolous fungi in South America by the first author in several countries (Bolivia, Chile, Columbia, Ecuador) and the second author in Central America (Guatemala, Panama), material of this species has never been collected so far. It is only known from the type locality where it was growing in a swamp mangrove forest that was especially rich in Graphidaceae.

NOTES. – *Xenonectriella* species have in common an ascomatal wall that reacts K+ violet-purple or purple and ascospores which finally turn brown and are normally ornamentated. Our sample should be compared with other species of that genus, especially with those growing on Physciaceae. *Xenonectriella leptaleae* (J. Steiner) Rossman & Lowen grows on related hosts such as *Physcia* and *Physconia* (Santesson 2004, Rossman et al. 1999), but differs from our species in several features. Most notably, the ascomata are obpyriform and much larger in *X. leptaleae* (150–325 × 130–240 µm). Other differences include the orange oil droplets abundant in the ascomata cells and the wider ascospores (8–12 × 6.5–8 µm) which are prominently tuberculate with age. *Pronectria echinulata* Lowen (Rossman et al. 1999) also grows on *Physcia* but in that species the acomatal wall is orange-brown, becoming darker in K but not turning purplish and the ascospores are echinulate and larger, (11–)12–14(–18) × 5.5–8(–10) µm. Furthermore, the ascomata grow in groups rather than solitarily as in the new species.

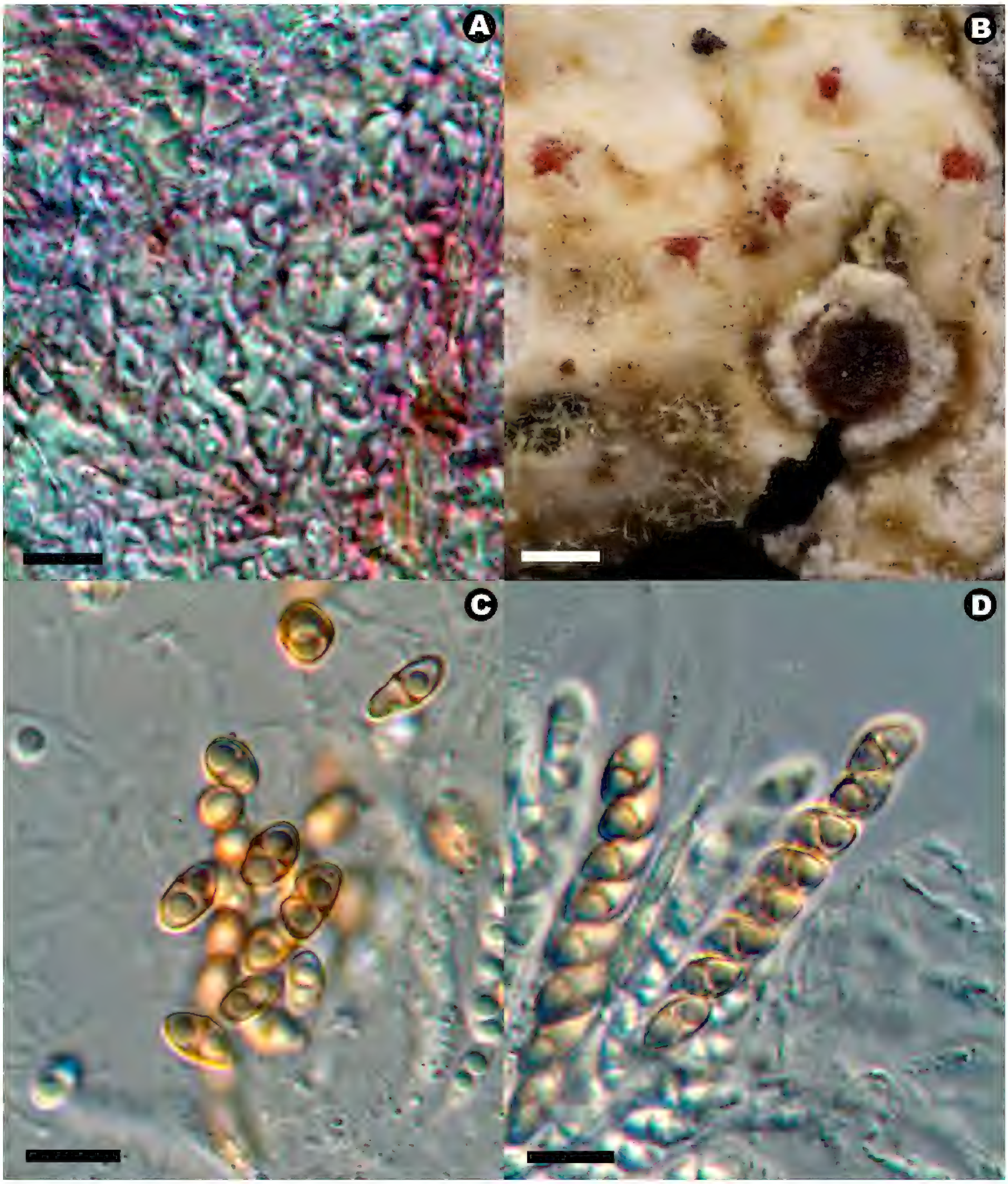

Figure 1, *Xenonectriella dirinariae* (all from the holotype). A, tissue of ascomata. B, habitus. C, mature ascospores outside of the ascus. D, ascospores in intact asci. Scales = 100 µm in B, 10 µm in A, C and D.

Based on the similiarity in ascospore sizes, the new species should also be compared to *Xenonectriella rosea* Etayo (Etayo & Sancho 2008). The ascospores of that species are slightly larger than those of *X. dirinariae* (9.5–12.5 × 6–7.5 µm). Additionally, *X. rosea* grows on a different host (*Pannaria*), the ascomata are pink or reddish and 120–250 µm in diam. and the ascospores are ornamented with large verrucae. Ascospore size, the presence of a torus, and the type of ascomata wall also invite comparison between the new species and *X. leptaleoides* (Etayo) Etayo (Etayo 2002). In that species, which grows on *Leptogium*, the ascospores are granular ornamented and the ascomata are larger (150–250 µm in diameter). Other species of *Xenonectriella* such as *X. aurantiaca* Etayo, *X. humilis* Etayo, *X. ornamentata* (D. Hawksw.) Rossman and *X. streimannii* (Kondratyuk, Coppins & D.J. Galloway) Rossman all differ from the new species in many features including host, ascomata colour, size of ascomata and asci. Most significantly, all of these species differ in having much larger ascospores or ascospores with some type of ornamentation.

***Xenonectriella leptaleoides* (Etayo) Etayo**

NOTES. – Previously this taxon was known from Colombia and Ecuador where it was reported as occuring on *Leptogium phyllocarpum* (Etayo 2002). This is the first report of *Xenonectriella leptaleoides* from the Dominican Republic and the West Indies. Although the ascospores in our sample are slightly different (8–10 × 3.5–4.5 µm vs. 7–9(–9.5) × 4–5(–6.5) µm *fide* Etayo (2002)), all other features are very similar to the description published by Etayo (2002).

Specimen examined. – **DOMINICAN REPUBLIC. SALCEDO PROV.:** NW of San Francisco de Macorís, W of road from Tenares to Gaspar Hernández, halfway to Los Cacaos, cocoa plantation from Altagracia Vargas, with small trees as fence post, 19°25'N, 70°21'W, 360 m, on *Leptogium* on *Theobroma*, 30.i.2008, *P. & B. van den Boom 39153* (B, hb. van den Boom).

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A review of the genus *Bulbothrix* Hale: species with gyrophoric, lecanoric or lobaric acids lacking vegetative propagules

MICHEL N. BENATTI[1]

ABSTRACT. – This study is a taxonomic review of nine species of *Bulbothrix* (Parmeliaceae, lichenized fungi) containing gyrophoric, lecanoric or lobaric acids and whose thalli do not form isidia, soredia or pustules. The current species delimitations are confirmed. New characteristics are detailed, some synonyms are rejected, others confirmed, and range extensions are given. Lectotypes are selected for *Parmelia coronata* (= *B. coronata*) and *P. glandulifera* (= *B. coronata*).

KEYWORDS. – Parmeliaceae, bulbate cilia.

INTRODUCTION

Bulbothrix Hale was proposed for a group of species called *Parmelia* Series *Bicornutae* (Lynge) Hale & Kurok. (Hale 1974), characterized by small, laciniate and usually adnate thalli, simple to branched bulbate marginal cilia, cortical atranorin, simple to branched rhizines, smooth to coronate apothecia, hyaline unicellular ellipsoid to bicornute ascospores 5.0–21.0 × 4.0–12.0 µm in size, and bacilliform to bifusiform conidia 5.0–10.0 × 0.5–1.0 µm in size (Elix 1993, Hale 1976). In a recent paper presenting revised generic concepts of parmelioid lichens based on molecular, morphological and chemical evidence, Crespo et al. (2010) found that *Bulbothrix* as currently defined was nested in the *Parmelina* clade and that some species grouped with *Parmelinella* Elix & Hale, making the genus paraphyletic.

As part of a taxonomic revision of the genus *Bulbothrix* (Benatti 2010), type specimens and additional material of many species of *Bulbothrix* were studied. These species are mainly characterized by having cilia with hollow basal bulbs, which contain differentiated (round) cells and an oily substance (Benatti 2011a, Feuerer & Marth 1997, Hale 1975). The first contribution toward this revision concerned new combinations for four species that had been placed in *Bulbothrix* (Benatti & Marcelli 2010) but which needed to be excluded due to the lack of true bulbate cilia. Subsequent contributions treated 1) the species containing medullary norstictic and protocetraric acids (Benatti 2012a), 2) those with medullary salazinic acid that do not form isidia, soredia, lacinulae or pustules (Benatti 2012b), 3) the species with medullary salazinic acid that form isidia, soredia or pustules (Benatti 2013a), and 4) the the species that contain medullary fatty acids or no medullary substances (Benatti 2013b) and a special treatment on the *B. goebelii* group (Benatti & Elix 2012). The present paper represents the sixth contribution in this series and discusses six species with gyrophoric acid [*B. affixa* (Hale & Kurok.) Hale, *B. amazonensis* Marcano, Galiz & Morales, *B. atrichella* (Nyl.) Hale, *B. coronata* (Fée) Hale, *B. schiffneri* (Zahlbr.) Hale, and *B. silicisrea* Marcelli & Benatti], two species with lecanoric acid [*B. bicornuta* (Müller Arg.) Hale, *B. confoederata* (W.L. Culb.) Hale], and one species with lobaric acid [*B. goebelii* (Zenker) Hale], that do not form lichenized diaspores (i.e., isidia, lacinulae, soredia or pustules) and thus are thought to reproduce by purely fungal propaglues (i.e., ascospores or conidia) produced in apothecia and pycnidia respectively.

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[1] MICHEL N. BENATTI – Instituto de Botânica, Núcleo de Pesquisa em Micologia, Caixa Postal 68041, São Paulo / SP, CEP 04045-972, Brazil. – e-mail: michel_benatti@yahoo.com.br

MATERIAL AND METHODS

Type material and additional specimens were borrowed from, or examined in, the following herbaria: BM, C, DUKE, FH, G, H, ICN, LD, M, NY, PC, S, SP, TNS, TUR, US and W. This material originated from Africa, North America, Central America, the Caribbean and South America and supplemented by that collected in Brazil during the last 30 years, mainly by the author and the members of the Lichenological Study Group of the Instituto de Botânica (GEL) in Brazil.

The methods and terminology used herein follow those detailed in Benatti (2012a). Bulbs on cilia, rhizines, apothecia and other thallus parts were checked using the clarification method of Benatti (2011a). Chemical constituents of the additional specimens examined were identified by thin-layer chromatography (TLC) using solvent C (Bungartz 2001), and compared with the data on labels left with the specimens. The types had their chemical constituents examined by John A. Elix using high performance liquid chromatography (HPLC), following the methods described in Elix et al. (2003).

Gyrophoric and lecanoric acids have similar reactions for the C and KC spot tests, but it was found that at least in *Bulbothrix*, the colors are noticeably distinct, especially when comparing specimens side by side. Those containing gyrophoric acid usually react C+ and KC+ rose (with a faintly white-bluish bright fluorescence under UV depending on concentrations), while those containing lecanoric have a stronger red reaction without a nitidous UV reaction. Microcrystal tests (G.E. and G.A.W.) were used to confirm the presence of these substances in all specimens studied, as the crystals are very different in shape and size. Lobaric acid was detected by a KC+ violet rose reaction in combination with a typical white-bluish bright fluorescence under UV light.

RESULTS AND DISCUSSION

Examination of the specimens outlined in the materials and methods section above confirmed the existence of nine species containing gyrophoric, lecanoric or lobaric acids that do not develop vegetative propagules. Below, these species are described in detail and their diagnostic characters are discussed. In many cases new morphological data are presented and the secondary metabolites present are clarified. Based on this study *Bulbothrix affixa*, *B. amazonensis*, *B. atrichella*, *B. confoederata*, *B. coronata*, and *B. schiffneri* are corticolous, while *B. silicisrea* is saxicolous. *Bulbothrix bicornuta and B. goebelii* are predominantly corticolous, but can rarely be saxicolous.

THE SPECIES

Bulbothrix affixa (Hale & Kurok.) Hale, Phytologia 28(5): 480. 1974.
Mycobank #341588.

≡ *Parmelia coronata* Fée var. *denudata* Vain. *in* W.P. Hiern., Cat. Afr. Pl. 2(2): 401: 1901. **TYPE: ANGOLA.** Huila (3800 ad 5500 ped. s. m.), in sylvis editis Montis Morro de Lopollo, ii.1860, ad truncos Olacinearum (*Apodytis dimidiatae* E. May), *F.M.J. Welwitsch 33* (TUR-V!, lectotype designated by Hale (1976); BM!, isolectotype).

≡ *Parmelia affixa* Hale & Kurok. *nom. nov. pro P. denudata* non *P. denudata* Hampe, Contrib. U.S. Natl. Herb. 36: 137. 1964.

FIGURES 1 AND 2.

DESCRIPTION. – Thallus subirregular laciniate, pale dusky gray in the herbarium, fragments up to 2.3 cm diam., submembranaceous, corticolous, upper cortex 7.5–10.0 µm thick, algal layer 17.0–25.0 µm thick, medulla 67.5–95.0 µm thick, lower cortex 10.0–15.0 µm thick. Laciniae anisotomic to partially irregularly dichotomously branched, 0.3–1.1 mm wide, contiguous, very adnate and adpressed, with flat, subtruncate apices, margins plane, smooth to subirregular, entire to slightly incised, rarely sublacinulate, axils oval to irregular. Upper surface smooth and continuous, becoming somewhat irregularly cracked in the center, laminal ciliary bulbs absent. Adventitious marginal lacinulae scarce on older parts, short, 0.2–0.4 × 0.1–0.2 mm, plane, simple, apices truncate or acute, lower side concolorous with the marginal zone of the thallus lower side. Maculae absent. Cilia black, apices simple becoming partially furcate or trifurcate, 0.05–0.25 × ca. 0.03 mm, with semi immersed bulbate bases ca. 0.05 (–0.10) mm wide, abundant

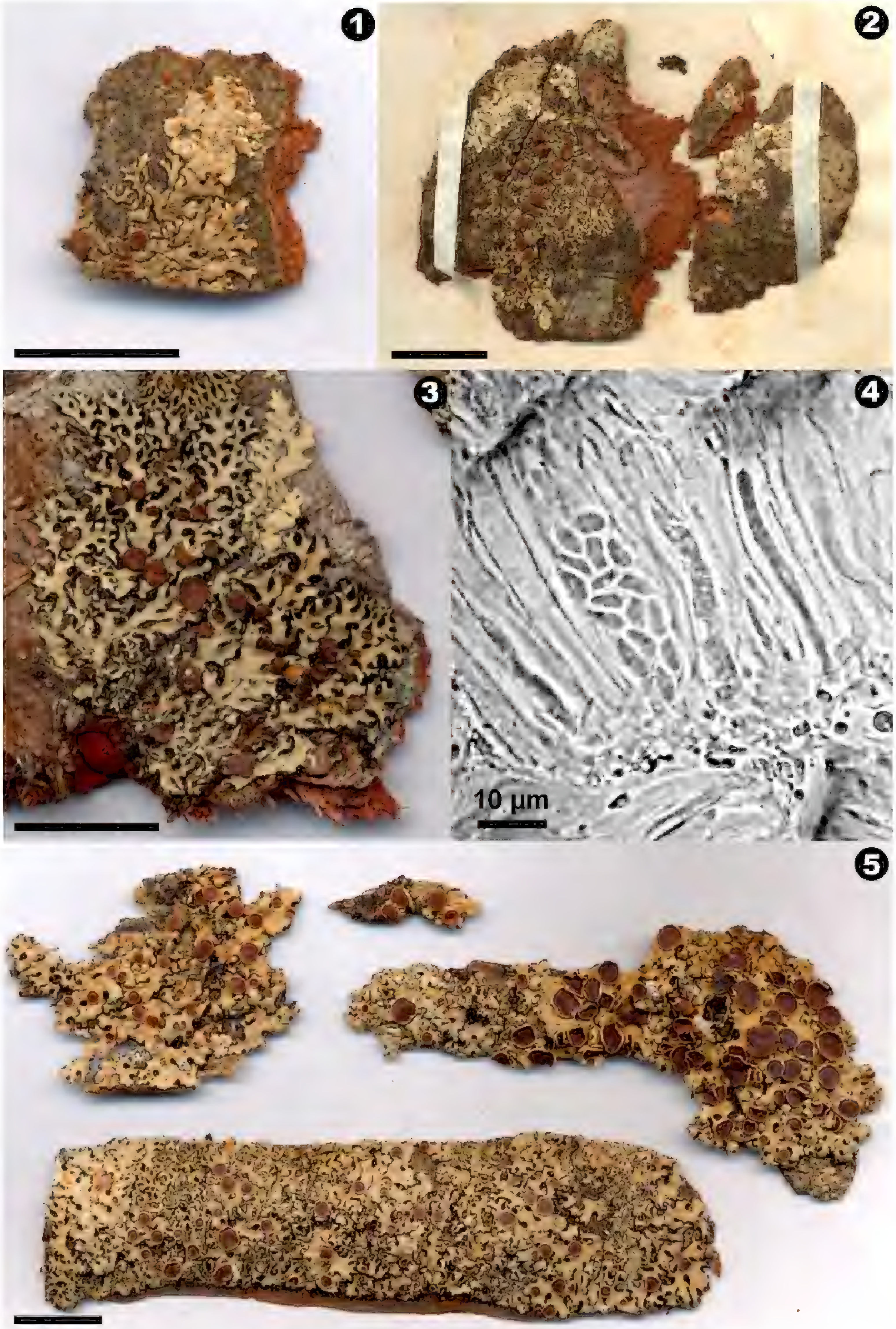

Plate 1, figures 1-5. 1, lectotype of *Bulbothrix affixa* (TUR-V). 2, isolectotype of *B. affixa* (BM). 3, a specimen of *B. amazonensis* (*Brako & Dibben 5804c*, NY). 4, detail of an ascus of *B. amazonensis* containing 16 ascospores. 5, lectotype of *B. atrichella* (H-NYL). Scale bars = 1 cm in 1-3 and 5, and 10 µm in 4.

throughout the margin spaced 0.05–0.10 mm from each other to occasionally contiguous, absent or scarce at the apices of the laciniae. Soredia, pustulae and isidia absent. Medulla white. Lower surface black, shiny, smooth to subrugose, densely rhizinate. Marginal zone black and indistinct, concolorous with the central parts to occasionally brown and narrowly attenuate, ca. 0.5 mm wide, shiny, smooth, rhizinate. Rhizines black, initially simple to partially furcate, without bulbate bases, 0.10–0.30 × ca. 0.05 mm, abundant, evenly distributed. Apothecia subconcave to convex, adnate, 0.2–1.6 mm diam., laminal, margin smooth to subcrenate becoming partially involute, coronate, amphithecium smooth, usually with ciliary bulbs. Disc light brown, epruinose, imperforate, epithecium 5.0–12.5 µm high, hymenium 20.0–37.5 µm high, subhymenium 15.5–25.0 µm high. Ascospores ellipsoid, oval or clavate, (6.0–) 7.0–10.5 × 4.0–5.0 µm, epispore ca. 1.0 µm. Pycnidia scarce, laminal, immerse, with black ostioles. Conidia not found.

CHEMISTRY. – Atranorin, gyrophoric acid (TLC/HPLC); upper cortex K+ yellow, medulla K–, C– or + pale rose, KC+ pale rose, P–, UV+ (?) weakly pale bluish (see also Hale 1976, Hale & Kurokawa 1964).

DISTRIBUTION. – Africa: Angola (Hale 1976, Hale & Kurokawa 1964, Vainio 1901).

NOTES ON THE TYPE COLLECTION. – The lectotype consists of a very small specimen, less than 1.5 cm in diameter, which is in good condition. It has several apothecia also in good condition, at different stages of development. The isolectotype is a larger fragment approximately 2.5 cm in diameter. Both specimens are on tree bark, and the isolectotype is glued to cardboard. There are other small fragments within the isolectotype probably representing a *Canoparmelia* species. The apothecia are coronate, but the coronation is somewhat irregular (vs. disposed continuously and concentrically on the margin as in *Bulbothrix coronata*). The bulbs are also common lower down in the amphithecium (i.e., below the margin), where they sometimes form apices resembling rhizines. Hale (1976) termed these structures "retrorse rhizines".

DISCUSSION. – The name *Parmelia affixa* was proposed because the name *P. denudata* had already been employed by Hampe (1843) for another species that is now considered a synonym of *Everniopsis trulla* (Ach.) Nyl. (Hale & Kurokawa 1964). At first Hale and Kurokawa (1964) did not identify the medullary chemistry of *Bulbothrix affixa* due to the small amount of material available. Later, Hale (1976) confirmed gyrophoric acid, citing the chemical spot test reaction as KC + faintly pink. In this species medullary spot tests react weakly, probably due to a low concentration of gyrophoric acid. The UV test showed a dubious, weak pale bluish reaction similar to that expected for lobaric acid, although microcrystal tests and TLC/HPLC detected only gyrophoric acid.

Hale (1976) thought that *Bulbothrix affixa* was the “parental” form (i.e. sexual morph) of *B. fungicola* (Lynge) Hale. The aspect of the laciniae, cilia and rhizines, the coronate apothecia and ascospore dimensions are very similar, the latter just having more evident medullary reactions (visibly C+ and KC+ rose) together with the production of small ciliate isidia (Benatti 2010).

Vainio (1890) asserted that *Parmelia coronata* (= *Bulbothrix coronata*) may or may not form isidia, proposing *P. coronata* var. *denudata* for specimens that never formed them. Hale (1976) compared *B. coronata* with *B. affixa*. The former is another species with the same medullary chemistry, coronate apothecia apothecia, lacking vegetative propagules. He separated it by its larger size and branched rhizines. I found that *B. coronata* differs from *B. affixa* by having the loose thalli, and pinnate, subdichotomous, somewhat subcanaliculate laciniae of larger width (0.5–2.0 mm vs. 0.3–1.0 mm wide), abundant and branched cilia and rhizines, and smaller ascospores (6.0–8.0 µm vs. 8.0–10.0 µm long).

Among other similar species, *Bulbothrix amazonensis* differs from *B. affixa* by the same features that separate it from *B. coronata*, as well as the fact that it has 16 ascospores per ascus (vs. eight), a unique character in the genus. *Bulbothrix apophysata* (Hale & Kurok.) Hale differs in being maculate and isidiate, with dichotomously branched cilia and rhizines, and by the presence of lobaric acid in the medulla instead of gyrophoric acid (Benatti 2010).

Swinscow and Krog (1988) did not report any specimens of *Bulbothrix affixa* from East Africa, which corroborates the supposition of Hale and Kurokawa (1964) that the species is probably more common in the southwest of the continent.

Additional specimen examined. – **ANGOLA:** Huila, Sá da Bandeira, 10 km N of the town, 2000 m alt., 3.ii.1960, *G. Degelius s.n.* (US).

Bulbothrix amazonensis Marcano, Galiz & Morales *in* Morales-Méndez et al. *in* Daniels et al., Flechten Follmann, Contributions to Lichenology in Honour of Gerhard Follmann p. 282. 1995. **TYPE: VENEZUELA. AMAZONAS:** face sul de Cerro Duida-Marahuaca, norte de Esmeralda, corticícola, *L. Galiz & V. Marcano AMA-56* (FUNDACITE in VEN[n.v.], holotype (not located at the time of this study, see below); B[n.v.], TFAZ[n.v.], isotypes).
Mycobank #415689.

≡ *Bulbothricella amazonensis* (Marcano, Galiz & Morales) Marcano, Galiz, Morales & Mohali *in* Marcano et al., Lichenologist 28(5): 422.

FIGURES 3 AND 4.

DESCRIPTION. – Thallus sublinearly laciniate, pale dusky gray in herbarium, up to 3.5 cm diam., subcoriaceous, corticolous, upper cortex 17.5−25.0 µm thick, algal layer 15.0−22.5 µm thick, medulla 35.5−42.5 µm thick, lower cortex 10.0−15.0 µm thick. Laciniae anisotomically, dichotomously to occasionally irregularly branched, 0.3−0.7 (−1.1) mm wide, contiguous, adnate and adpressed, with plane, truncate to subtruncate apices, the margins plane, sinuous to subirregular, entire, not lacinulate, the axils oval to rotund. Upper surface smooth and continuous, rarely with occasional irregular cracks, laminal ciliary bulbs absent. Lacinulae, even adventitious, absent,. Maculae weak and scarce, punctiform, laminal. Cilia black, apices initially simple or furcate, soon becoming very strongly dichotomously or irregularly branched, 0.05–0.35 × ca. 0.03 mm, with sessile bulbate bases 0.05–0.15 mm wide, abundant along the margins and usually contiguous to occasionally spaced ca. 0.05 mm from each other, their apices very intertwined with each other and with the rhizines, becoming absent or scarce at the apices of the laciniae. Soredia, pustulae and isidia absent. Medulla white. Lower surface black, shiny, smooth, slightly papillate, densely rhizinate. Marginal zone black and concolorous with the central parts to dark brown and narrow ca. 0.5 mm wide, shiny, smooth, rhizinate. Rhizines black, partially with brown apices, densely dichotomously to irregularly branched, occasionally with subtle dark basal bulbs, 0.10–0.50 × ca. 0.03 mm, evenly distributed, abundant, resembling a tomentum. Apothecia plane to subconcave, adnate to substipitate, 0.4–2.7 mm diam., laminal to submarginal, margin smooth to subcrenate, coronate with small and contiguous bulbs, amphithecium smooth, occasionally ornamented with scarce ciliary bulbs. Disc brown, epruinose, imperforate, epithecium 5.0–7.5 µm high, hymenium 30.0−37.5 µm high, subhymenium 30.0−45.0 µm high. Ascospores rounded to ellipsoid or oval, (4.0−) 5.5–9.0 × (2.5−) 3.5–4.0 µm, epispore 0.5−1.0 µm (always 16 per asci, of which usually 12 to 14 are visible in optical section). Pycnidia scarce, laminal to submarginal, immersed, with black ostioles. Conidia baciliform to weakly bifusiform 5.0−8.0 (−10.0) × 0.75 µm.

CHEMISTRY. – Atranorin, gyrophoric, lecanoric and orsellinic acids acid (TLC/HPLC); upper cortex K+ yellow, medulla K−, C+ and KC+ rose to reddish rose, P−, UV− (see also Lumbsch 1997). It is uncertain if lecanoric acid is a contaminant or an occasional, variable secondary metabolite.

DISTRIBUTION. – South America: Venezuela. Here it is reported for the first time from Brazil, Pará State (Marcano et al. 1996, Morales-Méndez et al. 1995).

NOTES ON THE TYPE COLLECTION. – Despite extensive efforts I have been unable to review any of the original material cited in the protologue of *Bulbothrix amazonensis*. The curator of VEN reported that the material whose label matches the holotype from the FUNDACITE herbarium, now conserved in VEN, is “a small twig with only a crust”, and that an isotype was not included in the collection. Staff from TFAZ answered that they could not locate an isotype in their herbarium either. The isotype from B is currently on loan and has not yet been returned. Additionally, none of the paratypes cited in the protologue could be located for this study.

DISCUSSION. – One of the specimens of this species found during my revision is one of the three thalli that make up the type collection of *Bulbothrix oliveirae* Fletcher. It is a small specimen, but in excellent condition with many apothecia, over a small piece of bark. The typification of the name *B. oliveriae* will be addressed in an upcoming paper by the author. Nonetheless it is clear that the name *B. oliveriae* should be applied to the remaining three thalli in type collection of that name and not to the thallus that is conspecific with *B. amazonensis*.

The material cited here agrees well with the description published in the protologue. Although the laciniae were reported by the authors to be 0.5−1.5 mm wide, the scale in the illustration of the holotype in Moralez-Méndez et al. (1995) indicates that the laciniae are narrower than described, apparently being slightly larger than those observed here. Morales-Méndez et al. (1995) described adnate, coronate apothecia containing 12–14 ascospores per ascus. Based on the specimens I have examined the number of ascospores should be 16. Their report of fewer ascospores is likely due to the tendency of ascospores to overlap so only 10 to 14 of these are visible in section. The ascospores display some variation in size, from asci with very small ascospores agreeing with the sizes published cited by Morales-Mendez et al. (1995), to asci with slightly larger and wider ascospores. The ascospore size range given here accounts for this variation.

Marcano et al. (1996) transferred *Bulbothrix amazonensis* to a new monospecific genus, *Bulbothricella*. That genus was circumscribed as having bulbate cilia, polysporous asci and pycnidia with oval conidia as the main characteristics. Those authors also reported umbilicaric acid for the species, and indicated medullary spot test reactions inconsistent with those given in the protologue (i.e., K + yellow→red, C+ red and KC+ yellow). The reactions observed in the material studied here match those given in the protologue and thus the report by Marcano et al. (1996) is considered to be an error. The medullary chemistry of the species was originally indicated as gyrophoric and 2-O-methylgyrophoric acid (Morales-Mendes et al. 1995). This was corrected to umbilicaric and gyrophoric acids by Marcano et al. (1996). Lumbsch (1997) later found gyrophoric, lecanoric and orsellinic acids, which was confirmed HPLC (J. Elix pers. comm.).

Lumbsch (1997) investigated an isotype and additional specimen of *Bulbothrix amazonensis*, and confirmed the typical features of *Bulbothrix* species, including the shape of conidia. He concluded that the authors had misinterpreted the species, and that the anomalous pycnidia with oval conidia belonged to a lichenicolous fungus. The supposed images of pycnidia containing obovate conidia published by Marcano et al. (1996), show the anatomical shape of the bulb (Fig. 5B therein), similar to those of marginal cilia (Figs. 4A and 4B therein). These structures clearly have the oily substance and idioblasts described by various authors in contrast to the true pycnidium shown in another image (Fig. 4C therein). In Figure 5B of Marcano et al. (1996) it is not possible to see conidiogenous hyphae interconnecting the structures, but only that they are apparently in a chain or close together, while several appear loose. The authors clearly interpreted the bulbs of the corona and amphithecia as pycnidia, much as Hale (1976) did once, and the oil idioblasts as obovate conidia. In the specimens seen for this study, some of these bulbs had the same apices as the marginal cilia, although this phenomenon was quite uncommon. The other defining characteristics of *Bulbothricella*, except for the number of ascospores and shape of conidia, were identical to those of *Bulbothrix*, as cited by the authors based on data from electron microscopy (Marcano et al. 1996). It should be noted that the bacilliform conidia illustrated by Morales-Méndez et al. (1995) are indeed typical of *Bulbothrix*.

Bulbothrix coronata is the most similar species to *B. amazonensis*. The two are macroscopically virtually indistinguishable, except for the tendency of thalli in *B. coronata* to be darker and always emaculate. The consistent difference is the number of ascospores per ascus, eight in *B. coronata* and 16 in *B. amazonensis* (Fig. 4). The size of the ascospores is also similar, only that in *B. amazonensis* asci containing ascospores smaller than those of *B. coronata* can also be found.

Among the other *Bulbothrix* species with coronate apothecia and medullary gyrophoric acid, *B. schiffneri* can be distinguished by its very narrow laciniae (rarely exceeding 0.5 mm wide) and the bicornute ascospores that are eight per ascus. *Bulbothrix affixa* differs by the usually simple cilia and rhizines, and in having eight ascospores per ascus. The ascospores in that species are also somewhat larger (ca. 7.0−10.0 × 4.0−5.0 μm). *Bulbothrix atrichella* differs by the having wider laciniae (1.0−2.5 mm wide), ecoronate apothecia, and eight spored asci. *Bulbothrix klementii* Hale was also compared to *B. amazonensis* by Morales-Méndez et al. (1995). This species differs in being isidiate, having very pale brown instead of black rhizines and lower cortex, eight ascospores per ascus, and medullary colensoinic acid (all spot tests negative) (Benatti 2013b).

Specimens examined. – **BRAZIL. PARÁ:** Serra do Cachimbo, Base Aérea do Cachimbo, ca. 20 km N of the border with Mato Grosso on Cuiabá-Santarém highway (BR-163), ca. 9º22'S, 54º54'W, alt. ca. 430–480 m, broad, sandy level plain along Rio Braço de Norte with sandstone exposure, low ridges and valleys to the N & S, 23.iv.1983, *L. Brako & M. Dibben 5804c*, (NY, collected as an admixture with the holotype of *B. oliveirae* Fletcher), 25.iv.1983, *L. Brako & M. Dibben 5964* (NY).

Bulbothrix atrichella (Nyl.) Hale, Phytologia 28(5): 480. 1974.
Mycobank #341590.

≡ *Parmelia atrichella* Nyl., Flora 68: 614. 1885. **TYPE: COLUMBIA.** Nova Granata, Pacho, alt. 1900 m, 1863, *A. Lindig 110* (H-NYL 35233!, lectotype (designated by Hale 1976); FH-TUCK!, M!, isolectotypes).

FIGURE 5.

DESCRIPTION. – Thallus sublinearly to subirregularly laciniate, dusky gray in the herbarium, up to 12.2 cm diam., subcoriaceous, corticolous, upper cortex 7.5−10.0 µm thick, algal layer 12.5−15.0 µm thick, medulla 30.0−37.5 µm thick, lower cortex 12.5−17.5 µm thick. Laciniae anisotomically, dichotomously to irregularly branched, 0.6–2.6 mm wide, slightly imbricate becoming partially crowded at the center, strongly adnate and very adpressed, with flat, subtruncate to occasionally acute apices, the margins flat, sinuous to subcrenate or subirregular, entire to slightly incised, frequently sublacinulate, the axils oval or irregular. Upper cortex continuous and smooth, occasionally with irregular cracks on older parts, laminal ciliary bulbs absent. Adventitious lacinulae frequent to abundant at the margins, commonly on older parts, short, 0.20–2.0 × 0.10–0.40 mm, plane, simple to furcate or irregularly branched, apices truncate or acute, lower side concolorous with the lower marginal zone. Maculae punctiform to effigurate, distinct at the distal parts, occasionally aggregate leaving the cortex bleached, becoming rare and disappearing at older parts. Cilia black, apices initially simple, soon becoming furcate and then dichotomously or irregularly branched, frequently intertwined and occasionally bent downwards, 0.05–0.30 (–0.50) × ca. 0.03 mm, with semi immersed bulbate bases 0.05–0.10 (–0.15) mm wide, abundant along the margins, contiguous to spaced 0.10 mm from each other, usually absent or scarce in the apices of the laciniae. Soredia, pustulae and isidia absent. Medulla white. Lower surface black, shiny, smooth to subrugose, densely rhizinate. Marginal zone concolorous with the central parts to brown and gradually changing color, 0.2–1.5 mm wide, shiny, smooth, slightly rhizinate. Rhizines black, occasionally brown when near the margins, initially simple or furcate soon becoming dichotomously or irregularly branched, without bulbate bases (although sometimes thickened), 0.10–0.40 (–0.60) × ca. 0.05 mm, abundant and covering the lower cortex, evenly distributed, almost like a tomentum. Apothecia subconcave to plane, adnate to sessile, 0.4−4.0 mm diam., laminal or submarginal, margin smooth, ecoronate, amphithecium smooth becoming subrugose, not ornamented. Disc pale brown, epruinose, imperforate, epithecium 7.5−10.0 µm high, hymenium 25.0−30.0 µm high, subhymenium 10.0−15.0 µm high. Ascospores rounded to ellipsoid or oval, (5.0−) 6.0−8.0 × (4.0−) 5.0−5.5 µm, epispore ca. 0.5 µm. Pycnidia abundant, laminal, immersed, with black ostioles. Conidia baciliform to weakly bifusiform, 5.0–7.0 × 0.75 µm.

CHEMISTRY. – Atranorin, gyrophoric acid (TLC/HPLC); upper cortex K+ yellow, medulla K−, C+ and KC+ rose to reddish rose, P−, UV− (see also Hale 1976, Nash & Elix 2002). A sample from the isolectotype at FH-TUCK also contains cortical chloroatranorin and small amounts of lecanoric, norstictic, and connorstictic acids and methyl-lecanorate in the medulla. The latter are suspected to be contaminants (J. Elix, pers. comm.).

DISTRIBUTION. – North America: Mexico (Nash & Elix 2002). South America: Colombia, Peru (Hale 1976, Nylander 1885).

NOTES ON THE TYPE COLLECTION. – The lectotype (Fig. 5) is a large specimen in good condition, consisting of three large and one small fragments, all with many apothecia at different stages of development, and several pycnidia. Some of the fragments are on tree bark, but none is glued to cardboard. I am unsure if they all belonged to a single thallus or to several thalli. The type is associated with drawings of ascospores and conidia, with measurements for each. The ascospores are represented as ellipsoid in this these drawings, with measurements 8.0–10.0 × 6.0–7.0 µm. The conidia are shown as subfusiform and measuring 6.0 × 0.6 µm. My measurements of the ascospores in the type showed a greater similarity to those from Hale (1976) while there was no significant difference regarding the size of the conidia. *Bulbothrix atrichella* is still the only species in the genus that lacks vegetative propagules, has gyrophoric acid and ecoronate apothecia.

The isolectotype at FH consists of two fragments on bark, one being a large thallus glued onto cardboard. It has many pycnidia, although a repeated search of these for conidia was not successful. This specimen is mixed with very small fragments of another species of *Bulbothrix* that has cilia with globose bulbs and simple apices, numerous short isidia, and probably contains salazinic or norstictic acid. The isolectotype at M is composed of two large and two small fragments, all in excellent condition, on tree bark. It has many pycnidia, although as was the case for the specimen in FH no conidia were found. It also includes several pieces of an isidiate *Bulbothrix* species, probably *B. ventricosa* (Hale & Kurok.) Hale judging by the overall characteristics and by the presence of laminal ciliary bulbs.

Parmelia granatensis Nyl. is presently considered a synonym of the isidiate species *Bulbothrix papyrina* (Fée) Hale. The specimens annotated as isolectotypes of this name by Hale that are deposited at BM and PC, are not the same as the lectotype. Rather, most of the thalli in these specimens are not isidiate and appear to represent *B. atrichella*. They lack isidia, have laciniae ca. 0.5–1.5 mm wide, similarly branched cilia, and many marginal adventitious lacinulae up to 1.5 mm long. The sizes of the ascospores and conidia also fall within the size range of those found in the type material of *B. atrichella*. There are two specimens marked as isolectotypes at BM. In addition to the non-isidiate thalli of *B. atrichella*, both specimens comprise a mixture of two other isidiate *Bulbothrix* species. None of these admixed isidiate thalli are also with the lectotype of *P. granatensis*, but rather represent *B. ventricosa* and *B. hypochraea* (Vain.) Hale.

DISCUSSION. – Hale (1976) made no mention of the branching pattern of the cilia apices or the presence of basal bulbs in the rhizines. He did however report the presence of marginal lobules and strong maculae on the upper cortex. These were easily noticed in the studied material. Nash and Elix (2002) also described specimens that match well the material studied here in many respects, including the occasional development of lacinulae at the thallus margins and ascospore size (7.0–8.0 × 5.0–6.0 µm). Those authors did not mention finding pycnidia, nor did they or note the presence or absence of maculae in their material.

Hale (1976) compared *Bulbothrix coronata* to *B. atrichella*. In agreement with his observations, this species seems to differ from *B. atrichella* by the emaculate upper cortex and presence of coronate apothecia. Another difference is that thalli of *B. coronata* usually form bulbs along the amphithecium, and occasionally on the upper cortex, whereas bulbs are not formed on these parts of the thallus in *B. atrichella*.

Bulbothrix continua (Lynge) Hale has laciniae and apothecia that are similar to those of *B. atrichella*, and the species also does not form vegetative propagules. However, *B. continua* differs by the absence of cortical maculae, has simple cilia and rhizines, and by the presence of salazinic acid.

Bulbothrix confoederata is also morphologically similar to *B. atrichella*, but differs in having narrower laciniae (ca. 0.5–1.0 mm wide), an emaculate upper cortex, usually non-lacinulate margins, variable color of the lower cortex (usually mixtures of brown), and by the presence of lecanoric acid as the medullary substance.

According to Hale (1976), *Bulbothrix goebelii* should be the isidiate counterpart of *B. atrichella*. However, the type material of *B. goebelii* is composed of thalli of different *Bulbothrix* species and, as was discussed by Benatti and Elix (2012), the thallus in the type collection that best matched the original description was not isidiate and contained mainly lobaric acid without accessory gyrophoric acid. That specimen has a black lower cortex with brown margins, and black rhizines, suggesting that *B. goebelii* is likely the non-isidiate counterpart of *B. apophysata*. Based on this reevaluation of the type of *B. goebelii* it is likely that the isidiate counterpart of *B. atrichella* is actually *B. papyrina*. That species is similar but is also emaculate (Benatti & Elix 2012), a difference that is comparable to that between such species as *B. viatica* Spielmann & Marcelli and *B. ventricosa* (Benatti 2012a).

Additional specimens examined. – **COLOMBIA:** Nova Granata, Socorro, alt. 1200 m, 1863, *A. Lindig s.n.* (BM, PC, isolectotypes of *Parmelia granatensis* that are not conspecific with the lectotype of that name which = *Bulbothrix papyrina*). **PERU:** María, San Martín, on trees, at top of ridge east of Tingo María, alt. 1020 m., in jungle, 30.viii.1949/19.ii.1950, *H.A. Allard 21472bis* (US).

Bulbothrix bicornuta (Müll. Arg.) Hale, Phytologia 28(5): 480. 1974.
Mycobank #341591.

≡ *Parmelia bicornuta* Müll. Arg., Flora 74: 377. 1891. **TYPE: BRAZIL:** Rio de Janeiro, *Leyland s.n.* (G!, lectotype (designated by Hale 1976); BM!, isolectotype).

FIGURES 6 AND 7.

DESCRIPTION. – Thallus sublinearly laciniate, dusky gray in the herbarium, fragments up to 4.0 cm diam., subcoriaceous, corticolous (also on twigs) to occasionally saxicolous, upper cortex 15.0–20.0 µm thick, algal layer 17.5–25.0 µm thick, medulla 62.5–75.0 µm thick, lower cortex 10.0–15.0 µm thick. Laciniae anisotomically, dichotomously to occasionally irregularly branched, (0.3–) 0.5–1.6 (–2.5) mm wide, contiguous to imbricate, slightly adnate and weakly adpressed, with flat, truncate to subtruncate apices, margins flat, smooth to sinuous or subirregular with a distinct black line, entire to slightly incised, rarely sublacinulate, the axils oval or irregular. Upper cortex continuous and smooth, laminal ciliary bulbs absent. Adventitious marginal lacinulae scarce on older parts, short, flat, 0.20–0.70 × 0.10–0.30 mm, simple or irregularly branched, truncate or acute, underside concolorous with the lower marginal zone. Maculae absent. Cilia black, with initially simple, double or furcate apices, soon becoming densely dichotomously or irregularly branched, 0.05–0.45 × ca. 0.03 mm, with semi immersed to sessile bulbate bases ca. 0.05–0.15 mm wide, abundant along the margins, spaced 0.5–0.10 mm from each other, becoming contiguous at the axils and some other parts, usually absent or scarce on the apices of the laciniae. Soredia, pustulae and isidia absent. Medulla white. Lower surface black, matt to shiny, smooth, papillate, densely rhizinate. Marginal zone brown to dark brown and attenuate, occasionally black and not distinct from the center, opaque to shiny, 0.5–1.5 mm wide, smooth, papillate, slightly less rhizinate than the center. Rhizines black, occasionally brown at the margins, initially simple or furcate soon becoming dichotomously or irregularly branched, partially with basal bulbs, 0.10–0.55 × ca. 0.03 (–0.05) mm, abundant and very intertwined except at the marginal zone, evenly distributed, almost like a tomentum. Apothecia subconcave to plane, adnate to sessile, 0.3–4.0 mm diam., laminal to submarginal, coronate, margin and amphitecium smooth, without ornamentations. Disc pale brown, epruinose, imperforate, epithecium 7.5–15.0 µm high, hymenium 35.0–47.5 µm high, subhymenium 12.5–20.0 µm high. Ascospores bicornute, crescent shaped or sigmoid, curvature open to closed, apices tapered occasionally almost acicular, lumen restricted to the central portion, (10.0–) 13.0–23.0 × 3.0–4.0 (–5.5) µm, epispore ca. 0.5 µm. Pycnidia frequent, laminal, immersed, with black ostioles. Conidia baciliform to distinctly bifusiform 5.0–7.0 × 1.0 µm.

CHEMISTRY. – Atranorin and chloroatranorin, lecanoric acid (TLC/HPLC); upper cortex K+ yellow, medulla K–, C+ and KC+ red, UV– (see also Hale 1976, Elix 1994).

DISTRIBUTION. – Australia (Elix 1994; questionable, see below); South America: Brazil – States of Minas Gerais and Rio de Janeiro (Hale 1976, Müller Argoviensis 1891a, Ribeiro 1998). Here it is reported for the first time from the Brazilian State of Pará.

NOTES ON THE TYPE COLLECTION. – The lectotype (fig. 6) consists of three small fragments in a reasonable state of preservation, not glued to the cardboard, with apothecia in better condition than those of the isolectotype. The isolectotype (fig. 7) consists of a fragment in similar condition to the lectotype, glued to the cardboard, but with most of the apothecia damaged. There are mature ascospores and conidia present in both specimens.

DISCUSSION. – The presence of lecanoric acid as the main medullary substance is rare in *Bulbothrix*, and currently only three such species are known in the genus: *B. bicornuta*, *B. confoederata* and *B. laevigatula* (Nyl.) Hale. Of these three, only the first has bicornute ascospores. The presence of a thick marginal black line mentioned by Ribeiro (1998) is quite noticeable in specimens of *B. bicornuta* and, like the medullary chemistry, is an unusual feature in *Bulbothrix*, being more typical of *Parmelinopsis* species.

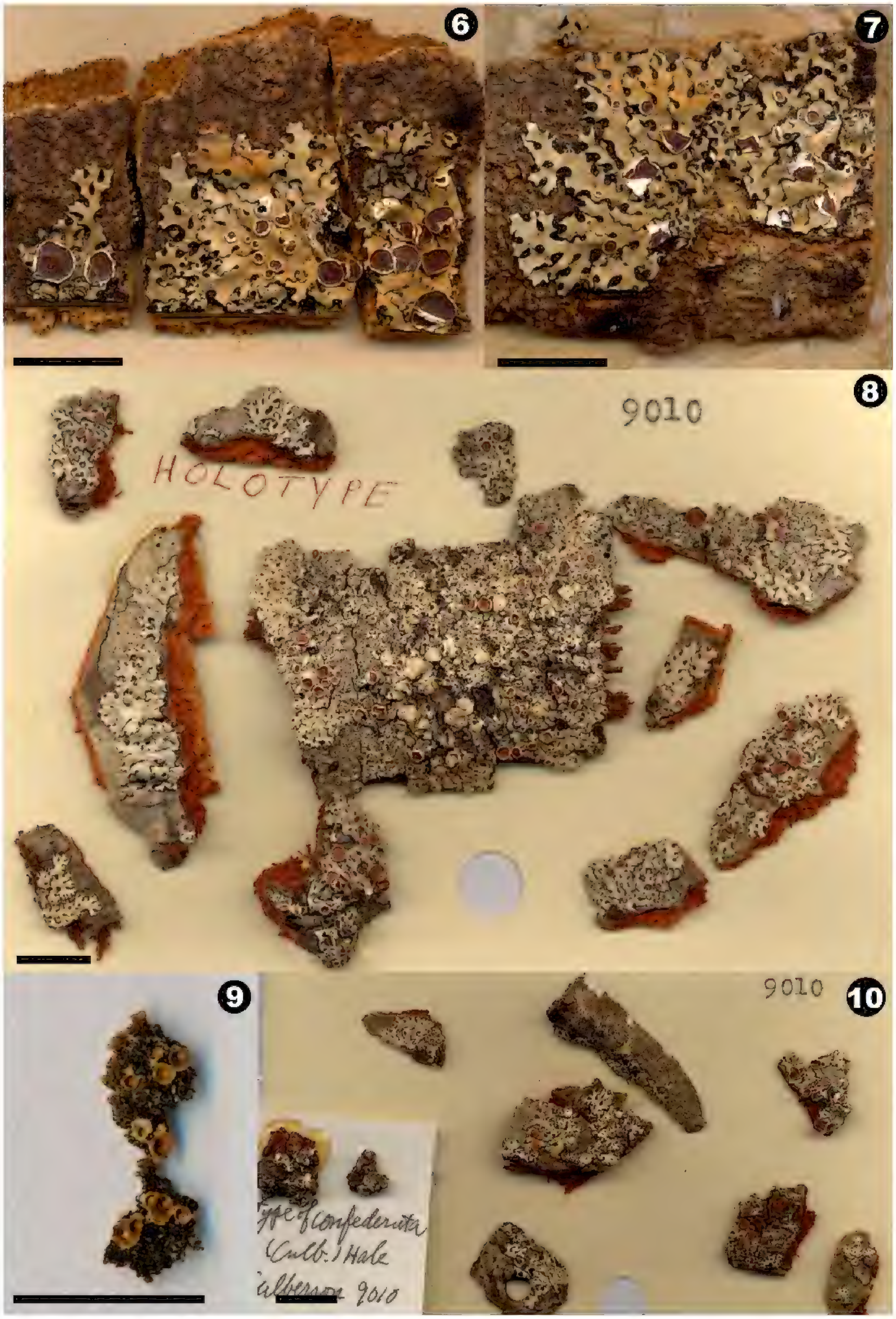

Plate 2, figures 6-10. 6, lectotype of *Bulbothrix bicornuta* (G). 7, isolectotype of *B. bicornuta* (BM). 8, holotype of *B. confoederata* (DUKE). 9, detail of the lower cortex of a small fragment of the holotype of *B. confoederata*. 10, an isotype of *Bulbothrix confoederata* (TNS). Scale bars = 1 cm.

Müller (1891a) described the ascospores of this species as semilunar with "utroque apice acuto in cornu subrectum parti cavae ipsius sporae subaequilongum sensim acuminatae" meaning:"on both tips acute, gradually acuminate into an almost straight horn about as long as the hollow part of the spore". In his monograph, Hale (1976) described the ascospores as 15.0−19.0 × 3.0−4.0 µm, noting that Müller (1891a) had given a range with smaller sizes. According to my measurements, the ascospores in the lectotype and additional specimens are actually larger than indicated by Hale. The least curved ascospores reach over 20 µm in length, while the most strongly curved ones measure between 10−13 µm long.

Elix (1994) reported *Bulbothrix bicornuta* from Australia and reported much smaller ascospores (8.0−10.0 × 4.0−5.0 µm) than those observed in the material studied here. This difference may indicate an additional species is involved, or may be due to the difficulty in measuring curved ascospores without digital means. Unfortunately the material was not available on loan at the time of this study.

Ribeiro (1998) described specimens of *Bulbothrix bicornuta* as having whitish thalli, wider laciniae (ca. 1.0−3.0 mm wide), a rugose surface, simple cilia and simple rhizines with small bulbs (0.05 mm wide), a rugose and veined lower cortex, and ascospores 12.0−13.0 × 2.0−4.0 µm. I examined the same material that was studied by Riberio and could confirm none of these characteristics. Rather the material represented typical *B. bicornuta* as described by previous authors and by myself herein.

Bulbothrix confoederata was compared to *B. bicornuta* by Hale (1976). While the two species share the same medullary chemistry, *B. confoederata* has narrower laciniae (ca. 0.5−1.0 mm wide), a lower cortex that is shades of brown, and smaller ellipsoid ascospores (5.0−8.0 × 3.0−5.0 µm). Hale (1976) also compared *B. bicornuta* to *B. schiffneri* and *B. semilunata*, both of which also have bicornute ascospores. The first differs in having more linear, narrower laciniae (ca. 0.2−0.5 mm), coronate apothecia, and gyrophoric acid as main medullary substance. The latter species differs in having narrower laciniae (also ca. 0.2−0.5 mm wide) and no secondary substances in the medulla.

Bulbothrix sipmanii Aptroot and Aubel (1999) is a recently described species with bicornute ascospores. This species is isidiate, has even narrower, more linear laciniae (ca. 0.1−0.3 mm wide), coronate apothecia, and contains gyrophoric acid as the main medullary substance instead of lecanoric acid. The *Bulbothrix* species with bicornute ascospores are all small lichens, mostly with very narrow laciniae that are typically ≤ 0.5 mm wide. The width of the laciniae in specimens of *B. bicornuta* is unusually large for the group, often three times wider than other similar species, and also with a pattern that also looks less linear and less dichotomously branched.

Among other similar species, *Bulbothrix laevigatula* is also comparable to *B. bicornuta*. It differs in the presence of isidia and smaller ellipsoid ascospores (6.0−9.0 × 4.0−6.0 µm). Müller (1891a) compared *B. bicornuta* to *Parmelia hookeri* Taylor due to overall aspect of the thallus and the coloration of the lower cortex. The name *P. hookeri* is now treated as a synonym of *B. laevigatula* (Marcelli et al. 2011).

Additional specimens examined. – **BRAZIL. PARÁ:** Serra do Cachimbo, 774 km N of Cuiabá on Cuiabá-Santarém highway (BR-163), just N of Mato Grosso boarder, ca. 9°30′S, 54°55'W, alt. ca. 400 m, low sclerophyll forest on ridge and openings along small stream, sandstone outcrops, 22.iv1983, *L. Brako & M.J. Dibben 5562* (NY); same locality data, ca. 8°45′S, 54°57'W, alt. ca. 350–500 m, tall canopy forest on W side of steep slope, dry vegetation on top of N-S ridge, 4.iv.1983, *L. Brako & M.J. Dibben 6690* (NY, US). **MINAS GERAIS:** Catas Altas Municipality, Caraça Mountain Range, Parque Natural do Caraça, 11.ix.1997, over tree trunk of dense cerrado (savannah) de candeia (*Vanillosmopsis* sp.), *M.P. Marcelli & C.H. Ribeiro 32068* (SP); same locality data, 11.ix.1997, over tree trunk at riparian wood, *M.P. Marcelli & C.H. Ribeiro 32047* (SP); same locality data, 9.ix.1997, over sun exposed rock at a track at the edge of riparian wood, *M.P. Marcelli & C.H. Ribeiro 31971* (SP).

Bulbothrix confoederata (W. L. Culb.) Hale, Phytologia 28(5): 480. 1974.
Mycobank#341594.

≡ *Parmelia confoederata* W.L. Culb. Amer. J. Bot. 48: 169. 1961. **TYPE: U.S.A. NORTH CAROLINA.** BRUNSWICK CO.: near Shallote, *Pinus palustris-Quercus laevis* woodland, viii.1959, on *Quercus laevis*, *W.L. Culberson 9010* (DUKE!, holotype; FH!, TNS!, US[n.v.], isotypes).

FIGURES 8–10.

DESCRIPTION. – Thallus sublinearly laciniate, dusky gray in the herbarium, fragments up to 4.5 cm diam., subcoriaceous, corticolous, upper cortex 7.5–15.0 µm thick, algal layer 12.5–37.5 µm thick, medulla 37.5–55.0 µm thick, lower cortex 10.0–12.5 µm thick. Laciniae anisotomically, dichotomously to irregularly branched, 0.4–0.9 (–1.2) mm wide, slightly imbricate, sometimes crowded in the center, very adnate and strongly adpressed, with flat to slightly involute, subtruncate to occasionally acute apices, the margins flat, sinuous to crenate, entire to incised, sublacinulate mainly at older parts, the axils oval. Upper cortex smooth to subrugose, continuous with few occasional irregular fissures on older parts, laminal ciliary bulbs absent. Adventitious marginal lacinulae common on older parts, short, 0.2–0.9 × 0.1–0.3 mm, plane, simple to furcate or rarely irregularly branched, apices truncate or acute, lower side concolorous with the lower marginal zone. Maculae absent. Cilia black to occasionally brown, apices initially simple or double, becoming furcate, trifurcate or partially subdichotomously to irregularly branched, 0.05–0.25 × ca. 0.03 mm, with semi immersed to sessile bulbate bases ca. 0.05 (–0.10) mm wide, abundant along the margins, spaced up to 0.05 mm from each other to contiguous in the axils and sometimes elsewhere, becoming less frequent at the apices of the laciniae. Soredia, pustulae and isidia absent. Medulla white. Lower cortex variable, mixed from pale brown to brown or dark brown, occasionally with black or dark brown spots, shiny to opaque, smooth, densely rhizinate. Marginal zone pale to dark brown, attenuate to concolorous with the central parts, 0.5–1.0 mm wide, shiny, smooth, slightly papillate and sparsely rhizinate. Rhizines pale brown to brown at the margins to dark brown or blackish in the center, initially furcate soon becoming dichotomously or irregularly branched, occasionally with subtle bulbate bases, 0.10–0.60 × ca. 0.03 mm, abundant, almost like a tomentum, partially agglutinated, evenly distributed. Apothecia plane to subconcave or convex, adnate to substipitate, 0.2–2.6 mm diam., laminal or submarginal, margin smooth to rugose, ecoronate, amphithecium smooth, without ornamentations. Disc pale brown, epruinose, imperforate, epithecium 5.0–15.0 µm high, hymenium 25.0–52.5 µm high, subhymenium 15.0–30.0 µm high. Ascospores rounded to ellipsoid, 5.0–8.0 (–9.0) × (3.0–) 4.0–5.5 µm, epispore ca. 1.0 µm. Pycnidia frequent, laminal, immersed, with black ostioles. Conidia baciliform to weakly bifusiform, 5.0–7.5 × ca. 1.0 µm.

CHEMISTRY. – atranorin, lecanoric acid (TLC/HPLC); upper cortex K+ yellow, medulla K–, C+ and KC+ red, UV– (see also Culberson 1961, Hale 1976). The isotype from FH also contained cortical chloroatranorin and traces of medullary gyrophoric acid together with the lecanoric, maybe a contaminant (J. Elix, pers. comm.).

DISTRIBUTION. – North America: United States of America (Culberson 1961, Moore 1968, Hale 1976, Brodo et al. 2001).

NOTES ON THE TYPE COLLECTION. – The holotype (fig. 8) consists of a large fragment about 4.5 cm in diameter and nine other smaller fragments, all with thalli growing over wood and glued to cardboard. The material is in excellent condition, with several mature apothecia and pycnidia. The isotype in FH consists of eight small fragments 0.5–2.5 cm in diameter, also in good condition, on wood, and glued to cardboard. The isotype in TNS consists of nine small fragments of the same size as those of FH. Most of them are damaged, although there are a few pycnidia and apothecia in good condition. The isotype stated to have been deposited in US could not be located. The lower cortex varies in all of these specimens from brown to pale brown, with margins usually paler than the center, while the rhizines are usually darker than the cortex.

DISCUSSION. – The rhizines of *Bulbothrix confoederata* are mostly dark brown or black, except near the margins. Due to the density of the rhizines and their usually dark bulbate bases, the false impression can arise that the lower cortex is black, when in fact it is brown. It is difficult to observe the bulbs in the rhizines, and they may develop randomly or at a specific stage in the development of the rhizines. The rhizines are usually more branched than the cilia. Adventitious marginal lacinulae were somewhat common in several of the specimens studied.

This species is still unknown outside of the Coastal Plain of southeastern North America (Culberson 1961, Moore 1968, Hale 1976, Brodo et al. 2001), and it is the only member of the genus thought to be endemic to North America (Hale 1976). It is also one of the only three known *Bulbothrix* species that contain lecanoric acid as the main medullary substance.

Except for the larger width of the laciniae and the lower cortex color, all characters in the specimens studied here are in accordance with the original description (Culberson 1961). Moore (1968) and Hale (1976) mentioned laciniae 0.5–1.0 mm wide, about half the width mentioned by Culberson (1961; 1.0–2.0 mm), and their measurements are more in accordance with my observations. Moore (1968) did note the bulbate marginal cilia. Culberson (1961), Moore (1968) and Hale (1976) reported the lower cortex as being black with brown margins. In the studied material the color of the cortex is actually somewhat variable, ranging from dark brown with some blackish spots (as in the holotype) to variable shades of brown (as described by Brodo et al. 2001).

Culberson (1961) mentioned the existence of pycnidia in this species, but did not give a description of the conidia. These are reported here for the first time and are typical for the genus.

Hale (1976) compared *Bulbothrix confoederata* to *B. laevigatula* and to *B. bicornuta*. The former species differs in forming isidia and by the wider laciniae (ca. 1.0–2.5 mm wide). The latter species differs in having wider laciniae ca. 0.5–2.5 mm wide, and larger bicornute ascospores (12.0–20.0 × 3.0–4.0 µm). Hale (1976) hypothesized that *B. confoederata* was the non-isidiate morph of *B. laevigatula*, or at least "a somewhat larger species, certainly not far". Based on their similar characteristics Hale's proposed relationship seems to be probable.

Bulbothrix atrichella is a similar species likely to be confused with *B. confoederata*. It differs by the wider laciniae (ca. 1.0–2.5 mm wide), maculate upper cortex, and presence of gyrophoric acid as main medullary substance. The color of the lower cortex is too similar to be used for a clear differentiation between the species, although in *B. atrichella* it is always dark brown with distinct margins rather than a mixture of colors.

Additional specimens examined. – **U.S.A. ALABAMA.** MOBILE CO.: Mobile Bay, Dauphin Island, on coastal dunes, 22.x.1967, on low shrub *Ceratiola ericoides*, *S. Tucker 7201* (DUKE). **FLORIDA.** DUVAL CO.: Jacksonville, sine date, on cypress, *W.W. Calkins 32* (DUKE). **GEORGIA.** CHARLTON CO.: Billy's Island, in open woods, iii.1966, on trees, *A.C. Skorepa & G.W. Folkerts 2475* (US). **MARYLAND.** WORCESTER CO.: at Longridge, in a dry oak-pine woods, vii.1982, on *Quercus* sp., *A.C. Skorepa 14815* (US). **NORTH CAROLINA.** ROBESON CO.: 12 mi SE of Maxton, viii.1958, on *Quercus rubra*, *W.L. Culberson 8084* (DUKE). **SOUTH CAROLINA.** CHARLESTON CO.: just N of the town of Isle of Palms, sine date, on *Quercus virginiana*, *W.L. Culberson 9036* (DUKE).

Bulbothrix coronata (Fée) Hale, Phytologia 28(5): 480. 1974.
Mycobank #341596.

≡ *Parmelia coronata* Fée, Essai Crypt. écorc. p. 123. 1825. **TYPE: SOUTH AMERICA:** location unknown, collector unknown (G! [fragment number 4], lectotype (**designated here**)).
≡ *Parmelia relicina* var. *coronata* (Fée) Müll. Arg., Flora 70: 318. 1887b.

= *Parmelia glandulifera* Fée, Essai Crypt. écorc. p. 123. 1825. **TYPE: SOUTH AMERICA:** location unknown[2], *F.W.H.A. von Humboldt & A.J.A. Bonpland s.n.* (G! [fragment number 4], lectotype (**designated here**)).

FIGURES 11–14, 17 AND 18.

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[2] It should be noted that Fée's citation of the type for *Parmelia glandulifera* was "Habitat in America meridionali, ad corticem Cinchonae Condamineae (Humb. et Bonpl.)", with the comment "Ce lichen est assez commun sur le quinquina Condamine." If Fée examined material taken from the same trees that were considered to represent *Cinchona condaminea* Bonpl. by Bonpland than it is likely that the type matrial of *P. glandulifera* is from the same region as that of *C. condaminea*. Bonpland (*in* Humboldt and Bonpland, Pl. Aequinoct. 1: 33, t. 10. 1808) described that taxon from material reportedly gathered near Loja, in southern Ecuador, and Ayabaca, in northwest Peru ("Habitat in Peruviae Andibus, prope Loxam et Ayavacam.") and noted in his observations about the species "J'ai compare les echantillons de notre plante, pris a Loxa, avec ceux envoyes du Perou par ... Jussieu...".

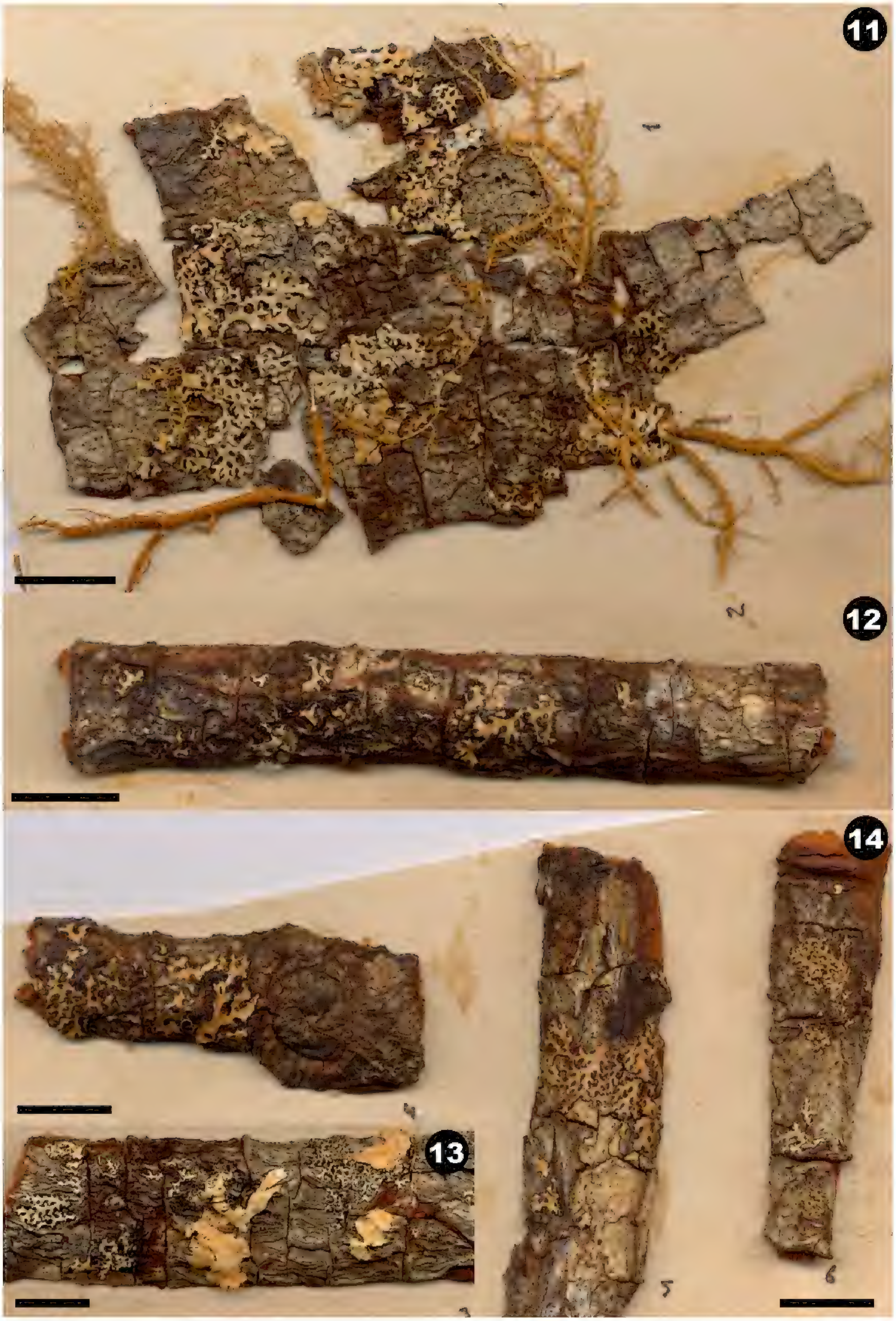

Plate 3, figures 11-14. Type collection of *Bulbothrix coronata* (G). The fragment marked as “4” is the lectotype. Scale=1 cm.

DESCRIPTION. – Thallus sublinearly laciniate, dark dusky gray in herbarium, fragments up to 1.4 cm diam., subcoriaceous, corticolous, upper cortex 15.0−20.0 µm thick, algal layer 15.0−25.0 µm thick, medulla 35.0−45.0 µm thick, lower cortex 10.0−17.5 µm thick. Laciniae anisotomically, dichotomously to occasionally irregularly branched, 0.5–0.9 (−1.1) mm wide, contiguous to slightly imbricate, ± adnate and weakly adpressed, with flat, truncate to subtruncate apices, margins flat, sinuous to crenate or irregular, entire, not lacinulate, the axils oval to irregular. Upper cortex smooth and continuous, with rare random fissures, laminal ciliary bulbs absent. Adventitious marginal lacinulae absent. Maculae absent. Cilia black, apices initially simple or furcate, soon becoming very densely dichotomously or irregularly branched 0.05–0.30 × ca. 0.03 mm, with sessile bulbate bases 0.05−0.10 (−0.15) mm wide, abundant along the margins, contiguous and intertwined between themselves and the rhizines, becoming absent or scarce at the apices of the laciniae. Soredia, pustulae and isidia absent. Medulla white. Lower cortex black, shiny, smooth, slightly papillate, densely rhizinate. Marginal zone black and concolorous with the central parts to castaneous brown and attenuate ca. 0.5 mm wide, shiny, smooth, partially rhizinate. Rhizines black with occasionally brown apices, usually very densely dichotomously or irregularly branched, partially with subtle bulbate bases, 0.10–0.40 × ca. 0.03 mm, abundant, almost like a tomentum covering the cortex, evenly distributed. Apothecia subconcave to plane, adnate to sessile, 0.4–2.2 mm diam., laminal to submarginal, margins smooth to subcrenate, coronate, the bulbs usually contiguous and of regular size, amphithecium smooth, ornamented with ciliary bulbs. Disc brown, epruinose, imperforate, epithecium 5.0–7.5 µm high, hymenium 25.0−32.5 µm high, subhymenium 20.0−25.0 µm high. Ascospores ellipsoid to oval, 5.0−10.0 × 4.0−5.0 (−6.0) µm, epispore 0.5−1.0 µm. Pycnidia scarce, laminal, immersed, with black ostioles. Conidia weakly bifusiform, 5.0−7.0 × 0.5 µm.

CHEMISTRY. – atranorin, gyrophoric acid (TLC/HPLC); upper cortex K+ yellow, medulla K−, C+ and KC+ rose to reddish rose, P−, UV− (see also Hale 1976).

DISTRIBUTION. – Africa: Angola (Vainio 1901), Ethiopia (Swinscow & Krog 1988), South Africa (Hale 1976), Tanzania (Krog 2000, Müller Argoviensis 1894). North America: Mexico (Culberson 1961, Hale 1976), United States of America (Egan 1978, Hale 1976, Wetmore 1976). Central America: Costa Rica, Jamaica (Müller Argoviensis 1891b, Tenorio et al. 2004). South America: Argentina (Calvelo & Liberatore 2002, Osorio 1981), Paraguay (Hale 1976), Brazil – States of Mato Grosso, Mato Grosso do Sul and Pará (Brako et al. 1985; Fleig & Riquelme 1991; Hale 1960, 1976; Lynge 1914; Marcelli 1993).

NOTES ON THE TYPE COLLECTION OF *PARMELIA CORONATA*. – The type specimen is composed of six fragments (Figs. 11–14) of different species belonging to several genera, all on tree bark. Considering the poor condition of the type, the extensive nature of the admixture, and the age of the name, a detailed explanation of each fragment is given below.

The fragment in the lectotype that is marked "1" is the largest and most intact, almost entirely consisting of a *Hypotrachyna* specimen without cilia and with dense dichotomously branched rhizines. A small piece of *Bulbothrix* was also found on this fragment and it represents a species without propagules and with a coronate apothecium that was cut and separated from the thallus. The ascospores in this material are 16 per ascus, which indicates it as *B. amazonensis*. The *Hypotrachyna* specimen reacted C+ and KC+ orange, typical reactions for barbatic acid, and might be *H. physcioides* (Nyl.) Hale or *H. monilifera* (Kurok.) Hale. The fragment marked "2" is quite damaged, and lacks apothecia. It is probably a *Bulbothrix* because of the marginal bulbate cilia; the medullary reactions are C + and KC + rose, and the rhizines are black. It could belong to *B. amazonensis* or *B. coronata*, but it was not possible to observe ascospores or maculae on the damaged upper cortex. The fragment marked "3" is glued on cardboard with drawings of asci and ascospores. However, this fragment has no apothecia, and has very eroded soralia. The medulla reacts C + and K + rose, and it is possibly a specimen of *B. leprieurii*.

The fragment marked "4' is the only one that fits *Bulbothrix coronata* as circumscribed by Hale (1976). Despite being in bad condition and having few coronate apothecia, most characteristics are consistent with the description. At first I suspected it to belong to the same species as in "1", but then I observed that it had 8 ascospores per ascus and was clearly emaculate. The medullary reactions are typical of those for gyrophoric acid, C + and KC+ rose. Thus, this fragment is here selected as the lectotype of *B. coronata*.

The fragment marked “5” has no apothecia, and may belong to the same species as the fragment marked “6”, because both have a KC+ violet red (UV+ whitish blue) medulla, black lower cortex, and brown rhizines. Fragment “6” has only one ecoronate apothecium. Apparently these fragments do not contain gyrophoric acid, but rather only lobaric acid, and in view of this possibly belong to *Bulbothrix goebelii* (Benatti & Elix 2012).

NOTES ON THE TYPE COLLECTION OF *PARMELIA GLANDULIFERA*. – A collection of *Parmelia glandulifera* (Figs. 17–18) from the Fée herbarium was labeled as an isotype of that name by Mason Hale. The same specimen was subsequently selected as the lectotype in his monograph of *Bulbothrix* (Hale 1976). The specimen contains six fragments from at least two different species of *Bulbothrix*, mounted on two separate pieces of cardboard. The fragments marked 1–3 are on one card (Fig. 17), 4–6 are on the second card (Fig. 18). There is a copper print of ascospore drawings including ovoid and bicornute ascospores, marked with the number 10, on the second card with fragments 4–6. This drawing is not however, identical with that published by Fée (1837: pl. XLII, fig. 10) which contains only oval ascospores.

The fragments marked 1, 2 and 3 have crescent-shaped ascospores, a densely rhizinate, black lower cortex, linear laciniae, agree with the species now known as *Bulbothrix schiffneri*. Fragment 5 possibly represents the same taxon as the aforementioned fragments, however its identity is uncertain as it lacks apothecia. Fragments 4 and 6 represent a different species with smaller, ellipsoid ascospores (6−10 × 4−6 µm), a sparsely rhizinate, black to dark brown lower side and larger laciniae ca. 0.5−1.2 mm wide. These fragments correspond well to both Fée’s illustration of non-bicornute ascospores and *B. coronata* as circumscribed by Hale (1976). Since the specimens selected as the lectotype of *P. glandulifera* by Hale (1976) is actually a mixture of two species, I have further narrowed the lectotypification here by selecting fragment 4 as the lectotype. Selection of this fragment as the lectotype maintains the current treatment *P. glandulifera* as a synonym of *B. coronata*. Concurrently it avoids the destabilizing effect that selecting a fragment corresponding to *B. schiffneri* would have because *P. glandulifera* is considerably older than the basionym of *B. schiffneri*.

Recognizing that the type of *Parmelia glandulifera* is an admixture of *Bulbothrix coronata* and *B. schiffneri* sheds some light on the treatment of the former two names by Müller (1887a, b). In reviewing Fée’s material he commented (Müller 1887a) that *P. glandulifera* was indistinguishable from *P. coronata*, except for a slight color difference, which tended to be darker in *P. glandulifera*. Later Müller (1887b) reduced *P. glandulifera* to synonymy with *P. coronata*, treating them collectively as *P. relicina* var. *coronata* (note *P. relicina* = *Relicina relicinula* (Müll. Arg.) Hale, a very different taxon from *Bulbothrix*). Müller’s confusion must have been due to the fact that he overlooked the fact that the type of *P. glandulifera* was mixed.

It is difficult to tell which fragment best fits the short description given in the protologue, since all have a similar gross morphology and habit. Fragment “4” is a logical choice considering that Fée mentioned coronate apothecia and that the fragment matches the description published by Hale (1976) that has been widely used by later workers. Additionally this specimen appears to correspond to that figured by Fée (1825: figs. 2a and 2b).

When Fée (1825) described *Parmelia coronata* he also introduced the name *P. glandulifera*. He distinguished that taxon from *P. coronata* by the wider and imbricate laciniae, the naked brownish lower margins, uplifted abundant cilia, and the presence of marginal “glands” spread over the margins of the apothecia (rather than restricted to the rim, i.e., coronate). My examination of the type collection of *P. glandulifera* confirmed that it is a mixture and that part of it actually belongs to the same species as *Bulbothrix schiffneri* (see comments under this species). Remarkably, Fée correctly interpreted the bulbs (i.e., as oil glands) rather than pycnidia as was done by later workers (e.g., Hale 1975, 1976). Following Fée’s description of *P. coronata* the name has been widely misapplied.

DISCUSSION. – Müller cited specimens of *Parmelia coronata* from Costa Rica (Müller 1891b) and Tanzania (Müller 1894), without descriptions or comments. Krempelhuber (1874) cited specimens of *P. coronata* from Brazil, but mentioned a K+ reddish medullary spot test, and ovoid ascospores 13.0−14.0 × 9.0−10.0 µm. Sprengel (1827) attributed material from China to *P. coronata*, describing the apothecia as coronate and mentioning “oval glands”. Vainio (1901) cited specimens of *P. coronata* from Angola, but provided no description or comment. All of these early reports of *P. coronata* require verification before they can be accepted. For now however, the author supports accepting reports whose descriptions fit with the overall characteristics of the species as presently understood.

Lynge (1914) reported wider laciniae (0.5–2.0 mm), and mentioned the ciliary bulbs which he interpreted as pycnidia appearing in large numbers both in the margin of the thallus and on the apothecia. He also mentioned "thickened ostioles", but in fact these are damaged bulbs with broken apices. Culberson (1961) reported *Parmelia coronata* from Mexico. Although the ascospores sizes provided by Culberson are the smallest found in the literature (5.0–8.0 × 4.0–5.0 µm), they are within the range I found. He did not mention bulbate marginal cilia, and treated the bulbs on the apothecia as pycnidia, without mentioning of conidia.

Swinscow and Krog (1988) reported *Bulbothrix coronata* for Ethiopia, describing wider laciniae (2.0–3.0 mm wide) compared to the material analyzed by me and to the other descriptions found. These authors also mentioned cilia that were not always clearly bulbate. The other characteristics and the dimensions of the ascospores (7.0–10.0 ×5.0–6.0 µm) are in accordance with my observations. The illustration published by Swinscow and Krog (1988: 24) shows apothecia with what appear to be true pycnidia on the amphithecia, not ciliary bulbs on a corona that borders the disc. It is thus possible that their material corresponds to a different species.

Marcelli (1993) described specimens of *Bulbothrix coronata* with laciniae that were partially linear and isotomically branched, with involute apices and abundant, non contiguous cilia that sometimes were bent downwards, and the lower cortex variably black to dark brown. His measurements of the ascospores are consistent with those generally found in literature. That author cited a P+ sulfur yellow reaction for some parts of the upper cortex and the occurrence of unidentified substances that fluoresce in UV light, one shining white and the other blue. Such substances were not detected in the studied material.

Althought Hale (1976) mentioned that a related species with vegetative propagules was not known for *Bulbothrix coronata*, it is morphologically similar to *B. subdissecta* (Nyl.) Hale. That species differs in the presence of isidia, maculae on the upper cortex, and in having ecoronate apothecia (Benatti & Elix 2012).

Bulbothrix bicornuta, *B. schiffneri* and *B. semilunata* were all compared to *B. coronata* by Hale (1976). These species differ in having larger bicornute ascospores (ca. 12.0–20 × 3.0–4.0 µm). *Bulbothrix bicornuta* also has medullary lecanoric acid whereas *B. semilunata* lacks medullary substances in addition to having ecoronate apothecia. These two species also have narrower linear laciniae, ca. 0.2–0.6 mm wide. *Bulbothrix amazonensis* is morphologically similar to *B. coronata* and has the same medullary chemistry. It can be differentiated by the maculate upper cortex and by the asci containing 16 ascospores (instead of eight). *Bulbothrix viridescens* was compared to *B. coronata* by Marcelli (1993). It differs in having apothecia that vary from ecoronate to coronate (Benatti 2013b), smaller ascospores (≤ 6 mm long), and by the absence of medullary substances.

Additional specimens examined. – **BRAZIL. PARÁ:** Serra do Cachimbo, Base Aérea do Cachimbo, ca. 20 km N of the border with Mato Grosso on Cuiabá-Santarém highway (BR-163), along Rio Braço de Norte, ca. 9°22'S, 54°54'W, alt. ca. 430–480 m, broad, sandy level plain with sandstone exposure, low ridges and valleys to the N & S, 25.iv.1983, *L. Brako & M. Dibben 5964* (NY). **MATO GROSSO:** Santa Anna da Chapada, 15.x.1902, *G.O.A. Malme s.n.* (LD); Serra dos Coroados, Chapada dos Guimarães, Buriti, Naturschutzgebiet der evangelischen Schule von Buriti, etwa 6 km südwestlich von Buriti, alt. 600 m, in einem submontanem regenwald, 8.vii.1980, an dünnen Ästchen, *K. Kalb & M.P. Marcelli s.n.* (M); Guiratinga, Rondonópolis-Guiratinga Highway, alt. 440 m alt., cerradão (dense savannah), 1.vii.1980, *M.P. Marcelli 9086* (SP). **MATO GROSSO DO SUL:** Aquidauana, Piraputanga town, alt. 200 m, middle part of the escarpment, 31.v.1990, on bush, *M. Fleig & I. Riquelme 147* (ICN). **MEXICO. OAXACA:** below Pan-Am. highway at Puerto Herrera (km 420), just NW of Yanhuitlan, 17°33'N, 97 °25'W, alt. ca. 2500 m, very steep and clayey open *Quercus arctostaphylos* woodland with shrubby *Penstemon* sp., small Agave sp., few cacti and many epiphytic Bromeliads (including *Tillandsia usneoides*), Orchidaceae (*Encyclia concolor*), and *Schoenocaulon* sp., terribly eroded and overgrazed slope, 20.viii.1960, *H.H. Iltis & R.K.F. Iltis 2691* (US). **SOUTH AFRICA. CAPE PROVINCE:** Simonstown District, Cape of Good Hope Nature Reserve, S.H. Skaife Field Station at Olifantsbosbaai, 34 18AD, seaside cliffs with scattered trees, 21.i.1986, *W.R. Buck 13857* (NY). **U.S.A. TEXAS.** BREWSTER CO.: N side of Chisco Mountains, Big Bend National Park, 29°16'N, 103°30'W, alt. 2130 m, 28.v.1977, on oak bark, *T.H. Nash 15065* (NY). **VENEZUELA. BOLIVAR:** Kweikin-ima Tepuy, hochland von Guayana, umgebung von Canaima, am Rio Varrao, 6°3'N, 62° 39'W, alt. 550 m, *H. Hertel & F. Oberwinkler* 10.004 (M).

Bulbothrix goebelii (Zenker) Hale, Smithsonian Contr. Bot. 32: 14. 1976.
Mycobank #341599.

≡ *Parmelia goebelii* Zenker *in* Goebel & Kunze, Pharmaceutische Waarenkunde 1: 134. 1827. **TYPE: SOUTH AMERICA:** "Auf officinellen Rinden" in Goebel "Auf Stücken der Loxachina.", collector unknown (M!, lectotype designated by Benatti & Elix 2012).

For a description, comments and illustrations, see Benatti & Elix (2012).

DISCUSSION. – The problematic concept of *Bulbothrix goebelii* was recently clarified showing that this was a misunderstood species and that some synonyms proposed by Hale are in fact different, good species (Benatti & Elix 2012). *Bulbothrix goebelii* is characterized by sublinearly laciniae ca. 0.5–3.0 mm wide, an emaculate upper cortex, abundant dichotomously branched cilia, the absence of vegetative propagules, a black lower cortex with brown margins or occasional random spots, dichotomously branched rhizines with basal or displaced bulbs, ecoronate apothecia, small and rounded ascospores, and the presence of medullary lobaric acid (the substance often concentrated in the apothecia).

Bulbothrix schiffneri (Zahlb.) Hale, Phytologia 28(5): 481. 1974.
Mycobank #341609.

≡ *Parmelia schiffneri* Zahlb., Denkschr. Akad. Wiss. Wien, Math.-Naturwiss. Kl. 83: 167. 1909. **TYPE: BRAZIL. SÃO PAULO:** prope Barra Mansa in districtu urbis Itapecerica, ca. 1000 m.s.m., in silvaticis, vi.1901, corticolous, *V. Schiffner s.n.* (W!, lectotype (designated by Hale 1976); W!, isolectotype).

FIGURES 15–16.

DESCRIPTION. – Thallus linearly to sublinearly laciniate, pale grayish to dark greenish brown in the herbarium, up to 2.2 cm wide, submembranaceous, corticolous, upper cortex 12.5–15.0 µm thick, algal layer 12.5–17.5 µm thick, medulla 15.0–22.5 µm thick, lower cortex 15.0–20.0 µm thick. Laciniae anisotomically, dichotomously to partially irregularly branched, 0.2–0.5 (–0.8) mm wide, contiguous to sometimes slightly imbricate or rarely crowded, slightly adnate and loosely adpressed, with flat, truncate to partially acute apices, the margin flat, smooth to subcrenate or irregular, entire to irregularly incised, slightly sublacinulate, with a distinct marginal black line, axils oval to irregular. Upper surface continuous, smooth, laminal ciliary bulbs absent. Adventitious marginal lacinules scarce, randomly distributed, short, simple to partially furcate, flat, 0.10–0.50 × 0.05–0.20 mm, truncate or acute, underside black or brown. Maculae absent. Cilia black, initially simple, soon becoming furcate, trifurcate, and then little dichotomously or irregularly branched, 0.05–0.15 (–0.25) × ca. 0.03 mm, with semi immersed to sessile basal bulbs ca. 0.05–0.10 mm wide, abundant along the margins, spaced 0.05–0.10 mm from each other to contiguous mainly in the laciniae axils, absent or scarce on the laciniae apices. Medulla white. Soredia, pustulae and isidia absent. Lower surface black, shiny, smooth to rugose or partially veined, slightly papillate, moderate to densely rhizinate. Marginal zone black and concolorous with the central parts to attenuated, dark or light brown, ca. 0.5–1.0 mm wide, shiny, smooth to subrugose or ±venate at the transition to the center, sparsely papillate, sparsely rhizinate. Rhizines black to dark brown, initially simple or furcate near the margins, soon becoming furcate and then becoming dichotomous or irregularly branched, partly with subtle or slightly enlarged basal bulbs, 0.05–0.40 × 0.02–0.05 mm, evenly distributed, frequently spot wise, more dense and tomentum-like, equally distributed. Apothecia laminal or submarginal, common, subconcave to plane or subconvex, coronate with small bulbs, 0.2–1.7 mm diam., sessile to adnate or rarely substipitate, margins smooth to crenate and partially interrupted by ciliary bulbs, amphithecia smooth, soon becoming ornamented, commonly developing ciliary bulbs; discs brown, epruinose, imperforate, epithecium 7.5–10.0 µm, hymenium 30.0–50.0 µm, subhymenium 15.0–25.0 µm; ascospores bicornute, subellipsoid with curved, acute apices to crescent shaped or sigmoid (often slightly comma-like), the apices thick with lumina restricted to the central part, 8.5–13.0 (–17.0) × 3.0–5.0 µm, epispore ca. 0.5–1.0 µm thick. Pycnidia laminal, scarce, immersed, with black ostioles. Conidia (none found on type) bacilliform to distinctly bifusiform, 5.0–9.0 × ca. 0.75 µm.

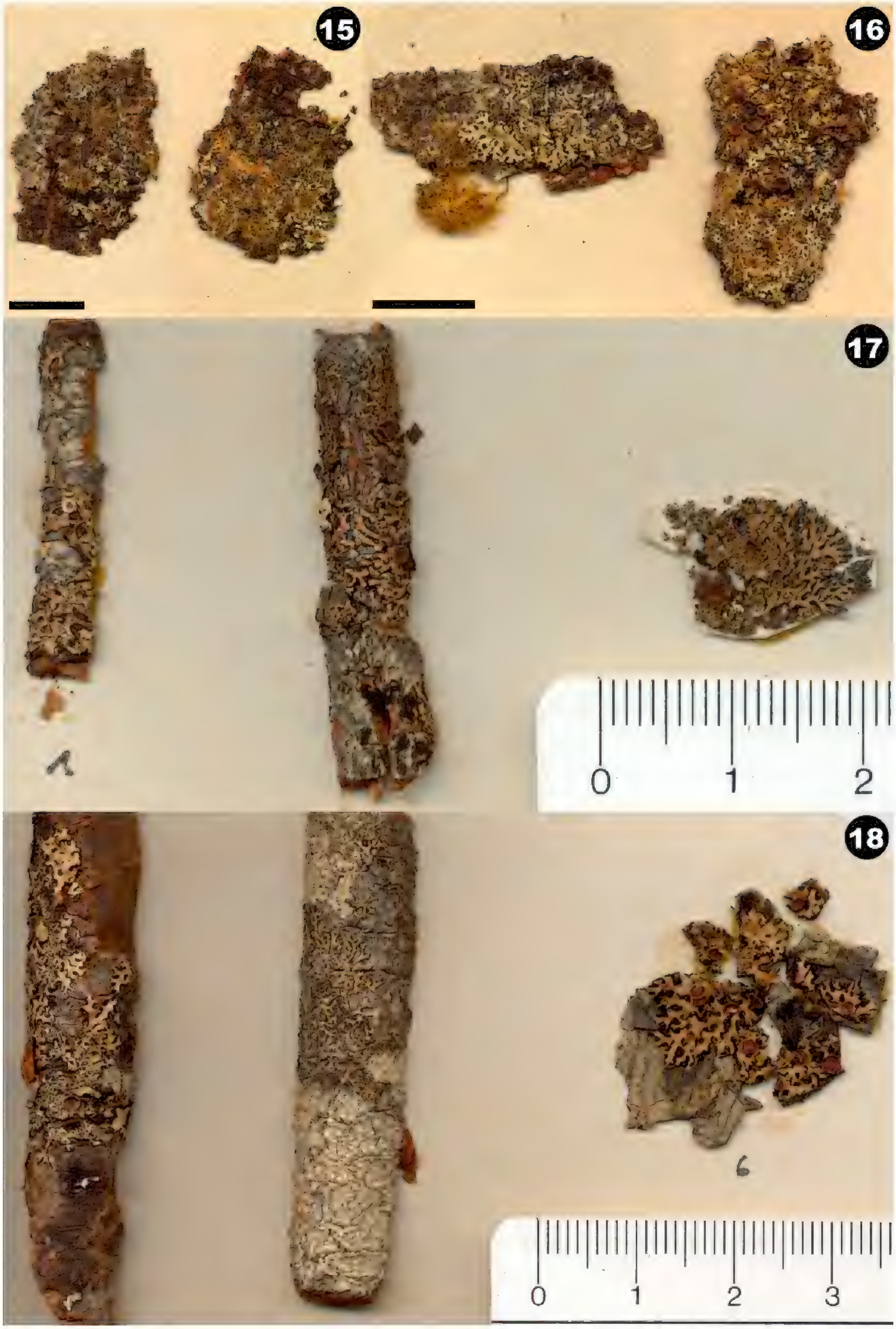

Plate 4, figures 15-18. 15, lectotype of *Bulbothrix schiffneri* (W). 16, isolectotype of *B. schiffneri* (W). 17-18, type collection of *Parmelia glandulifera* (G). Scale bars = 1 cm.

CHEMISTRY. – Atranorin, gyrophoric acid (TLC/HPLC); upper cortex K+ yellow, medulla K−, C+ and KC+ rose to reddish rose, P−, UV− (see also Hale 1976).

DISTRIBUTION. – Tropical America (unknown localities) and Brazil – Pará and São Paulo States (Brako et al. 1985, Fée 1825, Hale 1976, Zahlbruckner 1909). A record from China (Sprengel 1827) is not accepted here because Sprengel is unlikely to have had a correct interpretation of the species, and it has never been found again in East Asia.

NOTES ON THE TYPE COLLECTION. – The lectotype (Fig. 15) and isolectotype (Fig. 16) of *Bulbothrix schiffneri* consist respectively of two and three small fragments, partially covered by bryophytes, on small chips of bark, with very brittle thalli that are easily separable from the substrate. The lectotype is in good condition, while the isolectotype is somewhat damaged and blackened. Both have mature apothecia containing ascospores, and there are a few pycnidia, but conidia were not found. The thalli of this species are delicate and brittle. Because they are very thin, the removal of the upper cortex to expose the medulla for color tests is difficult. It is often removed together with the cortex because it is very loose. Also it is easily soaked with reagents which hinders the observation of the chemical tests. Consequently the C test usually shows only an ephemeral reddish rose reaction.

DISCUSSION. – When compared to the type material, the description of *Parmelia schiffneri* by Zahlbruckner (1909) contains several errors. The upper cortex was found not to be thicker than the lower cortex, although the former is very brittle. Zahlbruckner did not notice the presence of bulbs in the cilia, and interpreted the bulbs in the apothecia as pycnidia. He reported a negative C reaction in the medulla. Both Hale and Kurokawa corrected this error on annotations and in the description published by Hale (1976).

Zahlbruckner (1909) also described the ascospores as “heteromorphis, lacrimaeformibus, fabaceis vel semilunato-incurvis, utrinque vel solum in uno apice breviter acuminatis vel breviter cornutis” or, “heteromorphic, teardrop, bean or incurved semilunar shaped, acuminate or with short horns at two or only one apices”. In fact the bicornute ascospores of *Bulbothrix schiffneri* are clearly different from those of other species. They are on average half the size of most species (8.0–13.0 × 3.0–4.0 µm vs. 12.0–23.0 × 3.0–4.0 µm) taking into account the curvature, and vary from almost closed with very incurved apices (like a letter "C" or *lunato incurvae*, as described by Müller (1891a)), to a more open crescent. Rarely some ascospores may have only one acuminate apex (teardrop shaped), or none, assuming a somewhat allantoid shape.

Hale (1976) described this species as having 0.3–0.5 mm wide laciniae, 12.0 × 5.0 µm long ascospores, and a C+ rose, KC+ red medulla containing gyrophoric acid. This is in line with my observations of the type material. Previously Hale and Kurokawa (1964) had reported extremely small bicornute ascospores (4.0–5.0 µm long), narrow laciniae (0.1–0.2 mm wide) and a C– medullary spot test as part of a key without further details. It is likely that those authors based their key on the original description published by Zahlbruckner (1909).

One of the two specimens cited as *Bulbothrix schiffneri* by Brako et al. (1985) has ecoronate apothecia, larger bicornute ascospores (14.0–19.0 µm long) and medullary lecanoric acid. These characters indicate that it belongs to *B. bicornuta*.

According to Hale (1976) *Bulbothrix semilunata* differs from *B. schiffneri* by the more linear and regular dichotomous ramified laciniae, larger ascospores with a more evident crescent or sigmoid shape, and the negative chemical reactions in the medulla. My investigation of material of both species, including the lectotype of *B. semilunata*, indicates that in addition to these characters the cilia and rhizines of the latter are more dense and ramified (Benatti 2013b).

Aptroot and Aubel (1999) suggested that *Bulbothrix sipmanii* may be the isidiate counterpart of *B. schiffneri*. However, *B. sipmanii* has more linear laciniae, more ramified cilia and rhizines, and larger more evidently crescent-shaped ascospores. Based on these characteristics it seems more likely to be related to *B. semilunata*. The only other species morphologically similar to *B. schiffneri* is *B. coronata*. That species differs in having larger, wider laciniae (ca. 0.5–1.0 mm wide.) and smaller ellipsoid ascospores (6.0–10.0 × 4.0–6.0 µm).

Additional specimens examined. – **“SOUTH AMERICA”:** location unknown, *F.W.H.A. von Humboldt & A.J.A. Bonpland s.n.* (G, fragments 1–3 as an admixture in the lectotype of *Parmelia* *glandulifera*). **BRAZIL. PARÁ:** Serra do Cachimbo, Base Aérea do Cachimbo, ca. 20 km N of the border with Mato Grosso on Cuiabá-Santarém highway (BR-163), along Rio Braço de Norte, ca. 9º22'S, 54º54'W, alt. ca. 430–480 m, broad, sandy level plain with sandstone exposures, low ridges and valleys to the N & S, 25.iv.1983, *L. Brako & M. Dibben 5804b* (NY).

Bulbothrix silicisrea Marcelli & Benatti, Mycology 3(2): 130. 2012. **TYPE: BRAZIL. DISTRITO FEDERAL:** Brasilia, 1.xi.1994, on rock, *L.R. Fontes s.n.* (SP!, holotype).

For a description, comments and images, see Benatti (2012c).

DISCUSSION. – *Bulbothrix silicisrea* is characterized by very narrow sublinearly laciniae usually ≤ 0.5, an emaculate upper cortex, the absence of vegetative propagules, simple or furcate cilia, dark brown to black lower cortex with brown margins, simple to furcate rhizines with basal bulbs, coronate apothecia containing small, rounded to ellipsoid ascospores, and the presence of medullary gyrophoric acid.

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Chrysothrix galapagoana, a new species from the Galapagos Islands

KERRY KNUDSEN [1] AND FRANK BUNGARTZ[2]

ABSTRACT. – *Chrysothrix galapagoana* is described from the Galapagos Islands where it is considered to be endemic. It is most similar to the fertile species *C. placodioides*, described from historical collections from Brazil, but differs in having smaller mature pseudo-areolate granules and in reproducing asexually from granules usually produced on the upper surface of the thallus.

KEYWORDS. – Arthoniales, Ecuador, sterile crusts, South America.

INTRODUCTION

This study is a result of a general lichen inventory of the Galapagos Islands (Bungartz et al. 2009a, 2013) by the Charles Darwin Foundation (CDF). The Galapagos Archipelago comprises more than 123 oceanic islands, islets and large rocks that emerged from the sea as a result of volcanic hot spot activity; 14 islands are somewhat arbitrarily recognized because of their size as the principal islands (Snell et al. 1995, 1996). The Galapagos climate is unusually dry, with a hot and cool season and prevailing winds from the south and southeast (Trueman & d'Ozouville 2010). Five principal vegetation zones can be distinguished: coastal, dry, transition, humid, and high altitude dry (Bungartz et al. 2009b, Tye et al. 2002).

As part of the Galapagos Lichen Inventory the following islands have been visited and all vegetation zones were surveyed: Isabela (Volcán Sierra Negra, Volcán Alcedo, Volcán Darwin, Volcán Cerro Azul), Santiago (including Rábida, Bartolomé), Santa Cruz (including Santa Fé, Plaza Sur, Plaza Norte, Roca Gordon, Pinzón), Pinta, Española, Floreana, and San Cristóbal. Among the many new discoveries was a sterile yellow crust growing on basalt boulders in the dry zone, which we describe in this paper.

The cosmopolitan lichen genus *Chrysothrix* Mont. (Chrysothricaceae Zahlbr., Arthoniales Hessen *ex* D. Hawksw. & O.E. Erikss.) is currently comprised of 19 species (Laundon 1981a, 1981b; Mycobank 2013). Most species are only known as sterile crusts, few have been found fertile. The type of the genus is *C. chlorina* (Ach.) J.R. Laundon. The species are generally characterized by a thallus of yellow to yellow-green ecorticate granules of sizes up to 500 µm in diameter, but usually smaller, with a green algal photobiont. Fertile species generally have immarginate apothecia with *Arthonia*-type asci and hyaline 3–7 septate ascospores. Most species contain pulvinic acid derivatives as the major secondary metabolites, which give them their characteristic yellow color and inspired the etymology of the genus which means "golden hair". Only the recent addition to the genus, *C. caesia* (Flot.) Ertz & Tehler which was previously placed in *Arthonia*, lacks these pigments (Ertz & Tehler 2011, Nelsen et al. 2009).

The modern revision of the genus began with the excellent work of J.R. Laundon (Laundon 1981a, 1981b). Since 1981, 11 new species have been described from around the globe (Elix & Kantvilas 2007, Harris & Ladd 2008, Jagadeesh et al. 2006, Kalb 2001, Lendemer & Elix 2010, Thor 1988, Tønsberg 1994) and four species have been transferred to the genus (Elix & Kantvilas 2007, Ertz & Tehler 2011, Harris & Ladd 2008, Kalb 2001). Despite the progress in the revision of the genus, problems still remain. *Chrysothrix oceanica* Räsänen was rightly excluded from the genus by Laundon as a *Caloplaca* because of

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[1] KERRY KNUDSEN – Herbarium, Department of Botany and Plant Sciences, University of California, Riverside, CA 92521-0124, U.S.A. – e-mail: kerry.knudsen@ucr.edu

[2] FRANK BUNGARTZ – Biodiversity Assessment, Charles Darwin Foundation (AISBL), Puerto Ayora, Santa Cruz, Galapagos, Ecuador; postal address: Avenida Juan Gonzales N35-26 y Juan Pablo Sanz, Quito, Ecuador. – e-mail: frank.bungartz@fcdarwin.org.ec or frank.bungartz@gmail.com

the presence of anthraquinones but the name is still legitimate (Laundon 1981b; Mycobank 2013). In our opinion *C. candelaris* (L.) J.R. Laundon and *C. chlorina* are still heterogeneous and widely misapplied at least in Europe and North America. More taxa new to science are expected to be discovered, especially through the use of molecular analysis. In this paper we describe a new sterile species from the Galapagos Islands, *C. galapagoana,* the twentieth species in the genus. So far the new species has only been found on five of the Galapagos Islands surveyed during the Galapagos Lichen Inventory.

MATERIAL AND METHODS

Herbarium collections of the Galapagos Lichen Inventory are deposited at CDS; other Galapagos specimens from historical collections were also reviewed (B, CAS, COLO, FH, H, OSC, S), but no material of the new species was found among these collections. For comparison, non-Galapagos material of *Chrysothrix* was also examined from CANB, NY, and UCR, as well as the holotype of *C. placodioides* from S.

All specimens were examined with a Zeiss Stemi DV4 dissecting microscope and a Zeiss Imager A1 compound microscope equipped with differential interference contrast. Macro-photos were taken with a Nikon D300 and/or D7100, 62 mm Nikkor Micro Lens and R1C1 macro flash directly in the field, or using a Novoflex macro-table to take images of herbarium specimens; for photographic magnifications higher than 1:1 an extension tube or Novoflex bellows was used. For micro-photos the compound microscope is equipped with a phototube for the Nikon D300/D7100. Photos in the laboratory were taken with Nikon Camera Control Pro 2; all photos were databased with the program IDimager 5 using the Darwin Core XML schema to embed collection and identification information as XMP metadata (http://owl.phy.queensu.ca/~phil/exiftool/TagNames/DarwinCore.html). Photos were processed with Photoshop CS4.

Thallus granules were measured in water. Standard spot tests were performed, including both 10% and a stronger solution of potassium hydroxide (K). The terminology to describe leprose lichens follows Lendemer (2011). The term “pseudo-areolate” or “pseudo-areoles” means appearing to be distinct corticate areoles but actually being single unstratified ecorticate granules of large size.

Secondary metabolites were examined from a selection of specimens using standardized thin-layer chromatography (Culberson & Ammann 1979; Culberson & Johnson 1982; Orange et al. 2001, 2010). Instead of the conventional upright TLC tanks, a horizontal HPTLC developmental chamber was used (Arup et al. 1993). TLC plates were documented with a Nikon D300 and/or D7100 digital camera. Photos were taken immediately after running the solvent, in long wave (366 nm) and short wave (254 nm) UV light, before applying 10% H_2SO_4. After $H2_SO_4$ treatment and charring in a laboratory oven for approximately 8 min at 110ºC a second set of photos in daylight and short-wave UV (254 nm) were taken.

TAXONOMIC SECTION

***Chrysothrix galapagoana* K. Knudsen & Bungartz sp. nov.**
Mycobank #806041.

TYPE: ECUADOR. GALAPAGOS ISLANDS: ISLA FLOREANA: ca. 500 m S of La Lobería, ca. 200 m inland from coast, 1°17′12.69″S, 90°29′36″W, 20 m alt., dry zone, very open *Bursera* forest with *Waltheria ovata*, few *Scalesia affinis* and some grasses on lava flow, on E-exposed front of lava flow, sunny, wind- and rain-exposed, 16.i.2011, on rock, *F. Bungartz 9756* (CDS 47073!, holotype; CDS!, isotype).

DIAGNOSIS. – Similar to *Chrysothrix placodioides*, but differs in having granules generally much smaller, (150–)170–250(–290) µm in diameter, and in reproducing asexually from granules usually forming on the upper surface.

FIGURES 1A-C.

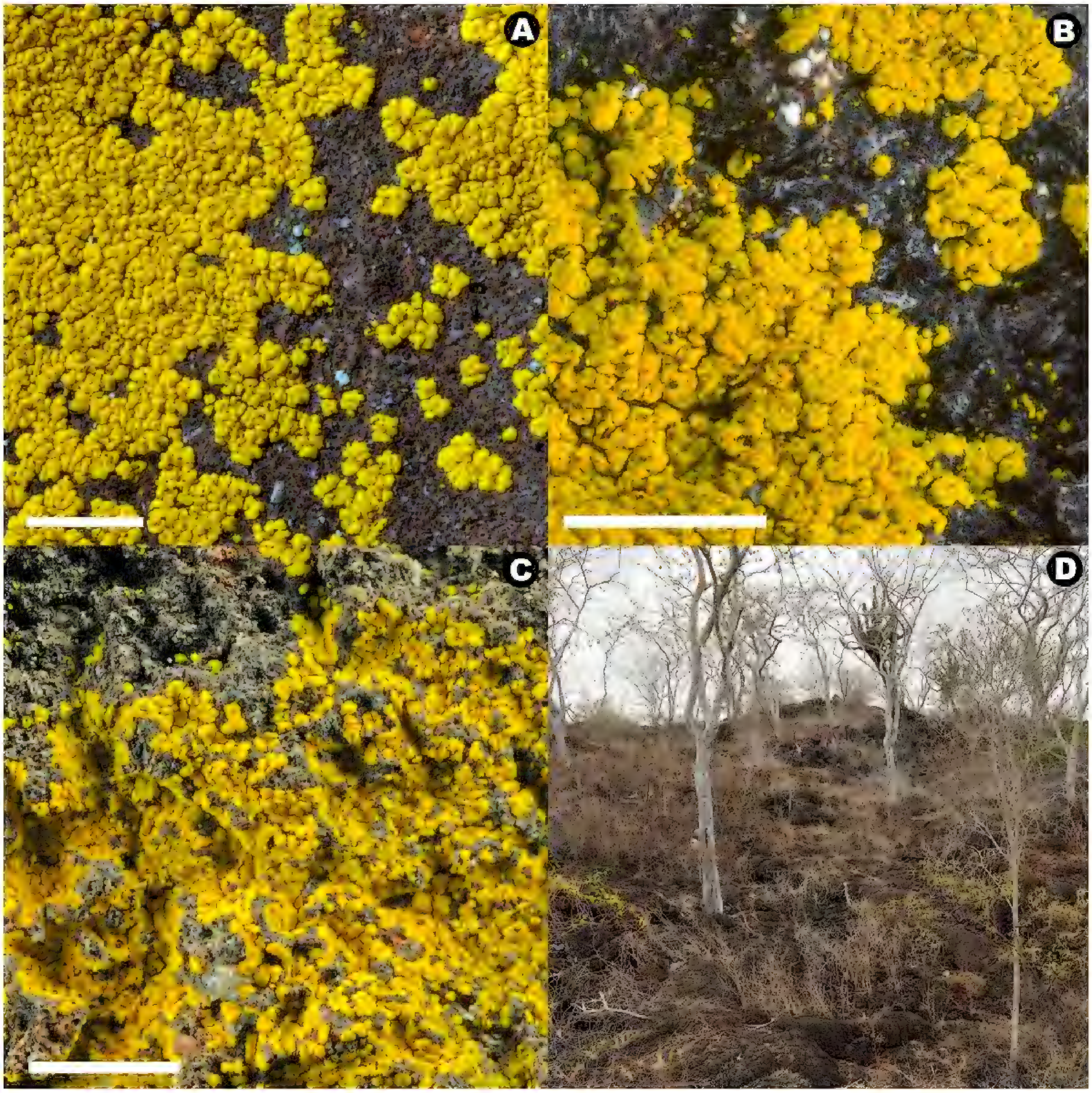

Figure 1. Pseudo-areolate growth of *Chrysothrix galapagoana* (A-C) and the type locality (D). A, overview of the pseudo-areoles with subsquamulose tendencies along the thallus margin (*Bungartz 9821*; scale 3 mm). B, detail of the thallus with granules forming on the surface of the pseudo-areoles (*Bungartz 9756*, holotype, scale 2 mm). C, thallus with less organized and more dispersed pseudo-areoles (*Bungartz 5256*; scale 5 mm). D, type locality of *C. galapagoana*: open *Bursera graveolens* forest (i.e., characteristic dry zone vegetation) on a lava flow near the Floreana coast.

DESCRIPTION. – *Prothallus* of sparse thin vegetative hyphae, not apparent around mature granules, unless thallus is damaged or eroded. *Hypothallus* lacking. *Thallus* of dispersed immature granules, very compact, coarse, (35–)42–57(–70) µm in diam. (n = 30), or of large mature granules (150–)170–250(–290) µm in diam. (n = 30), appearing pseudo-areolate, and producing immature granules on the upper surface which could be mistaken as soredia and are ultimately dispersed. Upper surface bright neon yellow, large granules pseudo-corticate, small granules ecorticate. *Photobiont* green, coccoid, 7–10 µm in diam. Apothecia not observed. Pycnidia not observed.

CHEMISTRY. – Calycin (major) and ±pulvinic dilactone (minor). Spot tests P−, K+ faintly reddish (10% solution), C−, KC−; UV− (dark).

DISTRIBUTION AND ECOLOGY. – The species is apparently endemic to the Galapagos Islands (Espanola, Floreana, Isabela, San Cristóbal, Santiago) where it grows on basalt boulders, rocks and cliffs in semi-shaded to sunny, exposed habitats. Most specimens were collected in the dry zone, but the species also occurs in immediate proximity to the coast or in the dry, open forests of the lower transition zone (figure 1D).

DISCUSSION. – *Chrysothrix galapagoana* is most similar to *C. placodioides*, described from historical collections made by G.O. Malme in Brazil (Thor 1988). Like *C. galapagoana,* this species also has pseudo-areolate granules but they are generally much larger (often over 500 µm in diameter, n = 10). These granules have a smooth ecorticate surface and do not produce smaller immature granules on their upper surface. No apothecia have been observed on C. *galapagoana*. Instead of reproducing asexually, *C. placodioides* regularly produces apothecia. The thallus of *C. placodioides* looks more continuous and pseudo-areolate than that of *C. galapagoana*, because new granules are also formed by vegetative division.

Chrysothrix candelaris as treated here contains calycin (major) and forms a distinctly leprose, unstratified, non-areolate thallus, dispersed to continuous, with mature granules 100–200 µm in diameter and immature granules from 10 µm in diameter, with a temperate distribution in Europe and not occurring in North America (Elix & Kantvilas 2007, Harris & Ladd 2008, Kalb 2001, Laundon 1981b). *Chrysothrix galapagoana* like *C. candelaris* produces calycin as a major secondary compound. It differs in having larger mature granules ((150–)170–250(–290) vs. 100–200 µm). The large granules of *C. galapagoana* also differ in being distinctly pseudo-areolate in appearance and in producing few to many immature granules ((35–)42–57(–70) µm) especially on the upper surface, which could be mistaken for soredia.

Three sterile species of *Chrysothrix* also produce calycin as a major or minor substance: *C. granulosa* G. Thor, *C. insulizans* R.C. Harris & Ladd, and *C. occidentalis* Elix & Kantivalis. *Chrysothrix granulosa* differs from *C. galapagoana* in producing diffractaic acid (major) in addition to calycin, having a distinct hypothallus (treated as a medulla by Thor (1988)), and having smaller granules mostly 25–42 µm in diameter (Thor 1988). *Chrysothrix insulizans* produces calycin as a major substance and is distinguished from *C. galapagoana* by smaller granules (20–50 µm), a leprose thallus not becoming distinctly pseudo-areolate, and in containing an unknown secondary substance (Harris & Ladd 2008). When Harris and Ladd (2008) described this species they emphasized that the species often forms "soralium"-like patches that resemble islands (etymology of *insulizans:* island-forming). Harris and Ladd (2008) did not discuss how these patches were formed and in revising material of *C. insulizans* we concluded these patches are formed by secondary aggregation of thallus granules. The "islands" are thus typical type 1 aggregated thalli of the common caesioalba subtype of leprose lichens (sensu Lendemer (2011)) and must not be confused with the pseudo-areolate growth of *C. galapagoana*, where large, mature granules themselves develop an "areolate" appearance. Further, the aggregations of granules in *C. insulizans* are likely not of diagnostic value and should not be stressed when identifying the species. *Chrysothrix occidentalis,* known from Australia and Norfork Island in the Southern Hemisphere, differs from *C. galapagoana* in producing leprapinic acid as the major substance with calycin only as a minor substance. Its thallus is not pseudo-areolate and is composed of smaller granules (mostly 20–80 µm) (Elix & Kantivalis 2007).

The only other species of *Chrysothrix* reported from the Galapagos Islands is *C. xanthina* (Vain.) Kalb (Bungartz et al. 2013). It produces pinastric acid as the major substance and has a leprose thallus of smaller granules (20–40(–45) µm). This species generally grows on both bark and rock (Kalb 2001; Kukwa & Knudsen 2011) and on those substrates it is also very common in the Galapagos, whereas *C. galapagoana* has so far exclusively been collected on exposed rock surfaces. *Chrysothrix xanthina* was recently reported new for Bolivia (Flakus et al. 2006). In the CDF Checklist of Galapagos Lichenized Fungi, *C. galapagoana* was treated as *Chrysothrix* aff. *occidentalis* (Bungartz et al. 2013).

Additional specimens examined. – **ECUADOR. GALAPAGOS ISLANDS: ISLA ESPAÑOLA:** trail from Bahía Manzanillo on the N-coast of the island to the highest point, dry zone, 1°21′40.601″S, 89°41′56.61″W, 48 m alt., open scrub of *Cordia lutea* and *Prosopis juliflora* with grasses and few trees of *Bursera graveolens* over weathered lava boulders, 11-.xi.2010, on S-exposed front of basalt boulder, sunny, wind- and rain-exposed, *F. Bungartz 9095* (CDS 45913); 1°21′24.89″S, 89°41′57″W, 24 m alt., dry zone, boulder field of weathered AA-lava with scarce vegetation of *Ipomoea habeliana*, one *Bursera* tree and few *Cordia lutea* shrubs, 11.xi.2010, on SW-exposed front of small basalt rock, semi-shaded, wind- and rain-exposed, *F. Bungartz 9000* (CDS 45818), on W-exposed overhang of basalt boulder, shaded, wind- and rain-sheltered, *F. Bungartz 8990* (CDS 45808), on top of basalt boulder, sunny, wind- and rain-exposed, *F.*

Bungartz, 8981 (CDS 45799), on SSW-exposed front of basalt boulder, semi-shaded, wind- and rain-exposed, *F. Bungartz 8987* (CDS 45805). **Isla Floreana:** between La Gigante and Playa de los Perros, a little inland from coast, E-side of island, 1°16′44.70″S, 90°21′36.8″W, 56 m alt., dry zone, very open vegetation of *Cordia lutea* with some *Prosopis juliflora* and other shrubs on NE-exposed slope with lava boulders, 17-.i.2011, on top of small basalt rock, sunny, wind- and rain-exposed, *F. Bungartz 9821* (CDS 47159). **Isla San Cristóbal:** Cerro Partido along trail from entrance to Cerro Pelado to El Ripioso, 0°51′23″S, 89°27′37″W, 376 m alt., transition zone, rocky SW-exposed slope of hill with *Jasminocereus thouarsii*, *Clerodendrum molle* var. *glabrescens*, *Psidium galapageium*, Bromeliaceae and ferns growing in rock crevices, 28.iv.2007, on top of basalt boulder, sunny, wind- and rain-exposed, *F. Bungartz 6646* (CDS 34866); from Punta Tortuga ca. 3 km inland close to Cerro Tortuga, 0°44′39″S, 89°23′32″W, 79 m alt., dry zone, young basalt lava flow of bare AA-lava, 25.iv.2007, on top of lava flow, sunny, wind- and rain-exposed, *F. Bungartz 6495* (CDS 34712), on top of "hornito"; sunny, wind- and rain-exposed, *F. Bungartz 6493* (CDS 34710). **Isla Santiago:** ca. 4.5 km inland from the E-coast, ± at the same latitude as Bahía Sullivan, 0°16′51″S, 90°37′10″W, 180 m alt., dry zone, lava field of older lava with scarce vegetation of occasional *Bursera graveolens* trees, shrubs (*Castela galapageia*, *Vallesia glabra* var. *pubescens*, *Alternanthera filifolia*) and *Mentzelia aspera*, 19.vii.2006, on E-exposed steep slope (80°) of basalt boulder, sunny, wind- and rain-exposed, *F. Bungartz 5256* (CDS 29471). **Isla Isabela:** Volcán Darwin, southwestern slope, above Tagus Cove, 0°13′43.29″S, 91°19′47.29″W, 724 m alt., lower transition zone, SW-exposed lava flow of weathered AA-lava with scarce vegetation (*Macraea laricifolia*, *Dodonaea viscosa*, *Croton scouleri*, *Cordia revoluta* and *Jasminocereus thouarsii*), 12.xi.2007, on W-exposed front of basalt boulder, sunny, wind- and rain-exposed, *F. Bungartz 7406* (CDS 37893); lava field between Tagus Cove and Caleta Negra at the W-coast of the island, ca. 500 m inland from the coast, 0°14′44″S, 91°22′55.89″ W, 12 m alt., dry zone, ragged lava field (AA-lava) bare of vegetation, 17.xi.2007, on SW-exposed front of small basalt rock, sunny, wind- and rain-exposed, *F. Bungartz 7968* (CDS 38478).

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Lichenicolous fungi and some allied lichens from the Canadian Arctic

MIKHAIL P. ZHURBENKO[1]

ABSTRACT. – Forty species of lichenicolous fungi and two allied lichens are reported from the Canadian Arctic, 30 being new to this area. Four species are described as new to science: *Lichenochora arctica* (on *Candelariella canadensis* and *Rinodina terrestris*), *L. rinodinae* (on *Rinodina mniaraea, R. roscida* and *R. turfacea*), *Llimoniella catapyrenii* (on *Catapyrenium cinereum* and *Catapyrenium* sp.) and *Opegrapha buelliae* (on *Buellia insignis*). *Arthonia almquistii, Cercidospora ochrolechiae, Dactylospora rhyparizae, Didymellopsis pulposi, Lichenochora lepidiotae, Skyttea dacampiae, Stigmidium mitchellii* and *Zwackhiomyces macrosporus* are reported new to North America; *Arthonia digitatae, Minutoexcipula mariana* and *Skyttea dacampiae* are reported new to the Arctic; *Arthonia digitatae, A. excentrica, C. verrucosaria, Lichenoconium pyxidatae, Merismatium heterophractum, Minutoexcipula mariana, Pseudopyrenidium tartaricola* and *Zwackhiomyces berengerianus* are reported new to Canada. *Candelariella*, *Lecidella*, *Megalaria* and *Rinodina* are reported as new host genera for *Arthonia almquistii*, *Megalaria* for *Cercidospora punctillata* and *Dactylospora deminuta*, *Protopannaria* for *Lichenochora lepidiotae*, *Lecidella* for *Skyttea dacampiae*, *Fuscopannaria* for *Stigmidium mitchellii*, *Sticta* for *Stigmidium peltideae* and *Fuscopannaria* for *Zwackhiomyces macrosporus*.

KEYWORDS. – biogeography, taxonomy, new species, parasites.

INTRODUCTION

To date 46 species of lichenicolous fungi have been reported from the Canadian Arctic, which represents about 13% of the total known species diversity of this fungal group in the entire Arctic Region (Diederich & Zhurbenko 2001, Kristinsson et al. 2010, Zhurbenko 2012). While processing geobotanical lichen collections from the Canadian Arctic (Zhurbenko et al. 2006) a number of lichenicolous fungi were detected. Results of their identification are presented in this paper, which enlarges to 75 the number of lichenicolous fungus species known from this part of the Arctic. Additionally, four species new to science are described, eight are reported new to North America and three new to the Arctic. Taxonomical observations on some insufficiently known species are provided.

MATERIALS AND METHODS

This study is based on 118 specimens, examined with Zeiss microscopes Stemi 2000−CS and Axio Imager A1 equipped with Nomarski differential interference contrast optics. Microscopical examination was done in water, 10% KOH (K), Lugol's iodine, directly (I) or after a KOH pre-treatment (K/I), phloxin, cotton blue or brilliant cresyl blue (BCr). The length, breadth and length/breadth ratio (l/b) of asci, ascospores and conidia are given (where possible) as: (min−){X−SD}−{X+SD}(−max), where min and max are the extreme values, X the arithmetic mean and SD the corresponding standard deviation. Measurements were taken from water mounts, unless otherwise indicated. Nomenclature of the host lichens

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[1] MIKHAIL P. ZHURBENKO – Laboratory of the Systematics and Geography of Fungi, Komarov Botanical Institute Russian Academy of Sciences, Professor Popov 2, St.-Petersburg, 197376, Russia. – e-mail: zhurb58@gmail.com

follows Esslinger (2012). The classification of the *Ascomycota* follows Lumbsch and Huhndorf (2007). Examined specimens are housed in the mycological herbarium of the V.L. Komarov Botanical Institute in St.-Petersburg (LE-Fungi).

The majority of the specimens cited herein were collected at two localities: 1) abbreviated ERI = **CANADA. NORTHWEST TERRITORIES:** Ellef Ringnes Island, Isachsen Bay, 78°47–48'N, 103°32–36'W, alt. 20–70 m, arctic desert, and 2) abbreviated PPI = **CANADA. NORTHWEST TERRITORIES:** Prince Patrick Island, Mould Bay, 76°13–14'N, 119°18–20'W, alt. 10–30 m, transition between arctic tundra and arctic desert. Additional abbreviations used in the text below are: NM – Nadezhda V. Matveeva; DW – Donald A. Walker; ap. – apothecia; th. – thallus/thalli. Lichenicolous lichens are designated by a superscript letter L (“$^{\text{L}}$”) preceding the name of the taxon at the beginning of each entry in the text.

THE TAXA

Arthonia almquistii Vain.

CHARACTERIZATION OF THE MATERIAL. – Ascomata black, more or less matt, epruinose, with minutely rough surface, rounded or elongated in surface view, often somewhat flattened at the top, 75–600 µm across, superficial, dispersed to aggregated, sometimes confluent (then up to 2 mm across). Exciple indistinct. Epithecium medium to dark olive brown, 10–15 µm tall, K–. Hymenium pale olive brown, 40–50 µm tall, I+ red, K/I+ blue. Hypothecium medium to dark olive brown, 40–80 µm tall. Apices of paraphysoids sometimes with dark caps, usually somewhat swollen, 2.5–4.5 µm wide. Asci broadly clavate, ca. 33–57 × 16–20 µm, with K/I+ blue apical ring, 8-spored. Ascospores narrowly obovate to clavate/skittle-shaped, (11.0–)12.9–15.5(–18.0) × (4.0–)4.7–5.5(–6.0) µm, l/b = (2.2–)2.5–3.1(–3.6) (n = 111, in water or I), 1-septate (a few non-septate evidently immature ascospores were also observed), not or slightly constricted at the septum, hyaline, smooth-walled, with halo 0.5–1.5 µm thick and many small guttules clearly seen in K. Pathogenicity not observed.

NOTES. – The examined material fits well the description of *Arthonia almquistii* (Coppins & Aptroot 2009: 157), but is unusual with respect to its host selection. So far the species has almost exclusively been known from saxicolous species of several unrelated genera (*Amygdalaria*, *Farnoldia*, *Koerberiella*, *Porpidia* and *Trapelia*; Hafellner & Türk 1995, Santesson et al. 2004, Triebel 1989). However, it has also been reported from the terricolous crustose lichen *Bilimbia sabuletorum* (Kukwa & Flakus 2009) and probably colonizes a wide range of Lecanoromycetes. Here the range of hosts for *A. almquistii* is expanded considerably to include the genera *Candelariella*, *Lecidella*, *Megalaria* and *Rinodina*. This is also the first report of the species from North America.

Specimens examined. – ERI: 29.vii.2005, on thalli of intimately mixed *Candelariella* sp., *Lecidella wulfenii*, *Megalaria jemtlandica* and *Rinodina terrestris* growing on soil, *DW* (LE 260636); 22.vii.2005, on *L. wulfenii*, *NM* (LE 260836, LE 260716); 22.vii.2005, on *M. jemtlandica*, *NM* (LE 260616, LE 260816); on *M. jemtlandica*, 23.vii.2005, *NM* (LE 260726).

Arthonia digitatae Hafellner

CHARACTERIZATION OF THE MATERIAL. – Apothecia 50–250 µm diam., black, aggregated to confluent. Epihymenium medium brown, hymenium pale smoke grey, hypothecium medium brown, all parts K–. Hymenial gel I+ blood red, K/I+ blue. Ascospores hyaline, 1-septate, with wider upper cell, not constricted at the septum, (9.5–)10–11.5(–12.5) × 4–4.5(–5) µm, l/b = (2.0–)2.3–2.7(–3.1) (n = 35, in water or I), occasionally with indistinct halo.

NOTES. – Here *Cladonia coccifera* is reported as a new host species for *Arthonia digitata*. This report represents the first one for Canada and the Arctic.

Specimen examined. – ERI: 25.vii.2005, on *Cladonia coccifera* (tops of more or less moribund cups), *NM* (LE 260706).

Arthonia excentrica Th. Fr.

NOTES. – In the specimens cited below the ascospores are rarely non-septate, occasionally with a halo approximately 1 µm thick, and measure (10.5–)11.5–14.5(–16) × (4.5–)5–6(–6.5) µm, l/b = (1.8–)2.2–2.8(–3.2) (n = 36). This is the first report of *Arthonia excentrica* from Canada.

Specimens examined (both on thalli of Lepraria gelida). – ERI: 23.vii.2005, *NM* (LE 260875). – PPI: 21.vii.2004, *DW* (LE 260695).

***Arthonia peltigerina* (Almq.) H. Olivier**

NOTES. – *Arthonia peltigerina* is widely distributed in the Holarctic and is also known from Chile in South America (Alstrup & Ahti 2007, Etayo & Sancho 2008) where it grows on *Peltigera* and *Solorina* species. The taxon was previously reported from Canada by Alstrup (2004) and Zhurbenko (2009b).

Specimens examined (all on upper and lower surfaces of lobe margins of Peltigera spp.). – ERI: 24.vii.2005, on *P. canina*, *NM* (LE 260885); 20.vii.2005, on *P. didactyla*, *NM* (LE 260865); 20.vii.2005, on *P. leucophlebia*, *NM* (LE 260895a); 22.vii.2005, on *P.* cf. *rufescens*, *NM* (LE 260845).

***Cercidospora ochrolechiae* Zhurb.**

NOTES. – This recently described species was previously known only from the Russian Arctic, where it is rather common (Zhurbenko 2010b). This is the first report of *Cercidospora ochrolechiae* from North America.

Specimen examined. – ERI: 20.vii.2005, on *Ochrolechia inaequatula* (th., occasionally ap.), *NM* (LE 260489).

***Cercidospora punctillata* (Nyl.) R. Sant. s.l.**

NOTES. – The species is known from a wide range of host genera (*Solorina* being the one of its type) and might be heterogeneous. One of the collections cited below (LE 260882) represents the first report of this species from the genus *Megalaria*. These records are the first report for *Cercidospora punctillata*, albeit in a broad sense, from North America, except Greenland where it was reported, for example, by Alstrup and Hawksworth (1990).

Specimens examined. – ERI: 23.vii.2005, on *Megalaria jemtlandica* (th.), *NM* (LE 260882); 20.vii.2005, on *Protopannaria pezizoides* (moribund bleached th. and/or ap.), *NM* (LE 260782); 24.vii.2005, *NM* (LE 260635, LE 260752); 28.vii.2005, *NM* (LE 260662); 20.vii.2005, on an unidentified terricolous lichen (th.), *NM* (LE 260812).

***Cercidospora stereocaulorum* (Arnold) Hafellner**

NOTES. – This taxon grows on *Stereocaulon* species and is widely distributed in the Holarctic and also known from Peru (Etayo 2010). It has previously been reported several times from Canada (Alstrup & Cole 1998, Zhurbenko & Daniëls 2003, Zhurbenko 2010a).

Specimen examined. – ERI: 26.vii.2005, on *Stereocaulon alpinum* (stems), *NM* (LE 260854a).

***Cercidospora verrucosaria* (Linds.) Arnold**

NOTE. – The species is newly documented for Canada and the American Arctic, excluding Greenland where it was reported by Alstrup et al. (2009).

Specimen examined. – ERI: 22.vii.2005, on *Megaspora verrucosa* (ap.: thalline margins), *NM* (LE 260702).

***Corticifraga peltigerae* (Fuckel) D. Hawksw. & R. Sant.**

NOTES. – This species was formerly known in Canada only from British Columbia (Alstrup & Cole 1998). Its distribution is here extended eastward to include the Northwest Territories.

Specimen examined. – ERI: 28.vii.2005, on *Peltigera canina* (th.), *NM* (LE 260644).

L*Dacampia hookeri* (Borrer) A. Massal.

NOTES. – This lichen begins its life as a juvenile parasite on *Solorina* species (Henssen 1995), and as such has sometimes been considered as a lichenicolous fungus and included in lists of lichenicolous fungi (Hafellner 2008).

Specimen examined. – PPI: 22.vii.2004, on sandy soil with moss remnants, *DW* (LE 260713).

***Dactylospora deminuta* (Th. Fr.) Triebel**

NOTES. – The specimen (LE 260449) reported below from the genus *Megalaria* documents a new host genus for this taxon. The remainder of the collections document the distribution and range of hosts of *Dactylospora deminuta* in the Northwest Territories.

Specimens examined. – ERI: 30.vii.2005, on *Biatora subduplex* (th.), *DW* (LE 260569); 25.vii.2005, on *Biatora* sp. (th.), *NM* (LE 260459); 24.vii.2005, on *Lecanora epibryon* (th.), *NM* (LE 260881); 26.vii.2005, on *Megalaria jemtlandica* (th.), *DW* (LE 260449); 25.vii.2005, on *Pertusaria* *octomela* (th.), *NM* (LE 260469); 26.vii.2005, *NM* (LE 260429); 28.vii.2005, *NM* (LE 260589); 27.vii.2005, on *Protopannaria pezizoides* (th.), *NM* (LE 260439); 28.vii.2005, *NM* (LE 260529); 24.vii.2005, on *Psoroma hypnorum* (destroyed ap.), *NM* (LE 260419); 24.vii.2005, on unidentified lichen crust on soil, *NM* (LE 260823). PPI: 18.vii.2004, on *Lecanora epibryon* (ap. and/or th.), *DW* (LE 260602); 21.vii.2004, *DW* (LE 260891); 22.vii.2004, *DW* (LE 260772); 2004, *DW* (LE 260893).

***Dactylospora* cf. *lobariella* (Nyl.) Hafellner**

CHARACTERIZATION OF THE MATERIAL. – Apothecia 150–200 µm diam. Paraphyses not or rarely branched above; apices distinctly swollen, 3–6 µm wide, with dark cigar brown caps. Hypothecium medium to dark brown. Ascospores hyaline then medium drab, ellipsoid to narrowly ellipsoid, straight or slightly curved, (10–)11.5–14(–15.5) × (4.5–)5–6 µm, l/b = (1.8–)2.0–2.6(–2.9) (n = 27), 1-septate, not constricted at the septum, finally verruculose.

NOTES. – The examined material fits well the species description published by Hafellner (1979) except for the apices of the paraphyses, which were reported there only slightly swollen and without distinct dark caps. So far this species has neither been reported from *Sticta* nor from the Arctic.

Specimen examined. – ERI: 23.vii.2005, on *Sticta arctica* (upper and lower surfaces of moribund lobe margins), *NM* (LE 260579).

***Dactylospora rhyparizae* Arnold**

NOTES. – The ascospores of the material cited below were somewhat longer than those reported by Keissler (1930: 247), viz. (12–)14–17(–18) × 5–6.5(–7.5) µm, l/b = (1.9–)2.1–3.1(–3.6) (n = 31) in the cited material vs. ca. 12–14 × 6–8 µm). This is the first report of *Dactylospora rhyparizae* from North America. Formerly it was known in the Arctic only from Iceland (Poelt & Obermayer 1991).

Specimen examined. – ERI: 23.vii.2005, on *Bryodina rhypariza* (th.), *NM* (LE 260409).

***Didymellopsis pulposi* (Zopf) Grube & Hafellner**

NOTES. – The specimen cited below represents the first report of this species from North America. Formerly it was known in the Arctic only from Iceland (Svane & Alstrup 2004).

Specimen examined. – ERI: 28.vii.2005, on *Leptogium gelatinosum* (th.), *NM* (LE 260715).

***Geltingia associata* (Th. Fr.) Alstrup & D. Hawksw.**

NOTES. – The collections cited below extends the distribution of this species eastward in Canada to the Northwest Territories. Formerly it was known in Canada only from British Columbia (Alstrup & Cole 1998).

Specimens examined. – ERI: 23.vii.2005, on *Ochrolechia* cf. *inaequatula* (th.), *NM* (LE 260713); 24.vii.2005, on *Thamnolia vermicularis* var. *subuliformis* (th.), *NM* (LE 260519).

***Lichenochora arctica* Zhurb. sp. nov.**

Mycobank #805163.

FIGURE 1.

DIAGNOSIS. – Similar to *Lichenochora lecidellae*, but finally with medium brown ascospores and not gall-inducing.

TYPE: CANADA. NORTHWEST TERRITORIES: Ellef Ringnes Island, Isachsen Bay, 78°47'N, 103°37'W, alt. 35 m, arctic desert, polygonal barren, on thalli of *Candelariella canadensis* and partly *Rinodina terrestris* growing on mineral soil with plant remnants, 29.vii.2005, *D. Walker s.n.* (LE 260655, holotype).

DESCRIPTION. – *Ascomata* perithecial, black, glossy, surface rough to rugose, ovoid, pyriform or subglobose, 90–260 µm diam., with a tiny pore, protruding only in ostiolar area to almost superficial; the interior filled with numerous lipid droplets, I and K/I–; dispersed to aggregated in groups of 50 or more, arising singly or contiguous to fusing by a few. *Exciple* in surface view of *textura angularis*, of cells 5–22 µm across; in cross section 30–40 µm thick, of 5–8 layers of tangentially elongated cells; inner cells hyaline to pale brown, with walls 0.5–1 µm thick; outer cells dark brown, K+ olive, with walls 2.5–5 µm thick. *Periphyses* abundant, hyaline, unbranched, 15–35 × 2–4.5 µm, 0–2-septate, guttulate, merging with

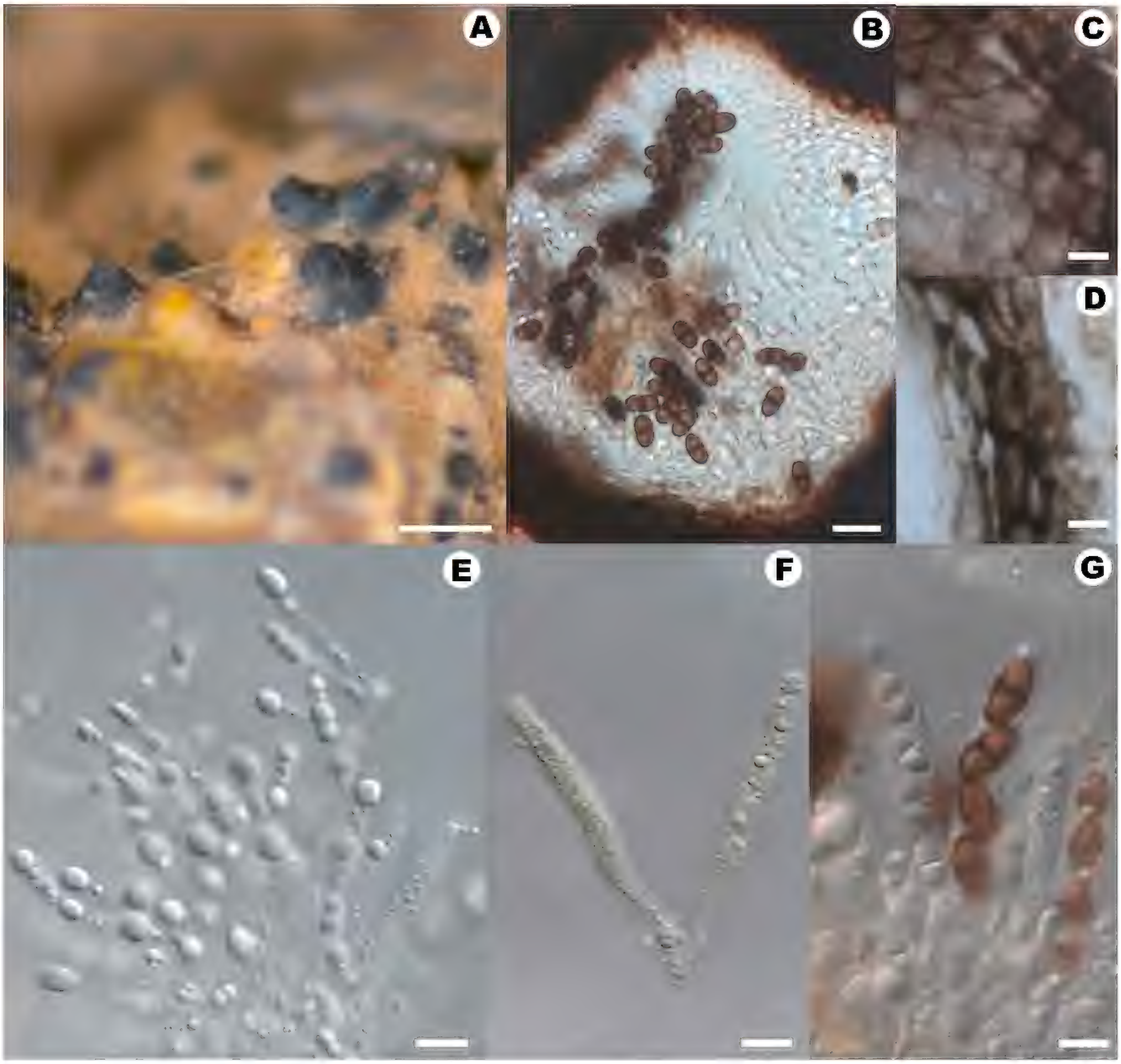

Figure 1, *Lichenochora arctica* (all from LE 260874 except for C and D, which are from the holotype). A, ascomata habitus. B, ascomata in cross section (in water); note ascospores and hamathecium. C, exciple in surface view (in K/I). D, exciple in cross section (in K). E, paraphyses (in K). F, immature asci (in I). G, mature asci (in water). Scales = 200 µm in A, 20 µm in B and 10 µm in C-G.

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paraphyses; ostiolar canal lined by hyaline to brown, unbranched, 2–3-septate filaments, 10–20(–30) × 1.5–2.5 µm, sometimes with enlarged apices. *Paraphyses* hyaline, branched, septate, usually markedly constricted at the septa, with small and large oil droplets, 30–60 × 3–8 µm, composed of strongly varying in size cells with delicate walls, evidently disappearing with maturation. *Asci* developing from the basal hyaline parenchymatous layer, subcylindrical, functionally unitunicate, wall apically usually not thickened, (57–)58–70(–75) × (7–)8–10(–12) µm (n = 10, in I), 4-spored, I and K/I– except cytoplasm becoming yellow. *Ascospores* hyaline then pale and finally medium brown, K+ olive, ellipsoid, obovoid or exceptionally subglobose, ends usually rounded, (8.0–)12.1–15.1(–22.0) × (5.5–)6.7–7.9(–9.5) µm, l/b = (1.1–)1.7–2.1(–2.6) (n = 221, in water, I or K), 1-septate or exceptionally simple, not or rarely slightly constricted at the septum, cells often equal and typically with one large oil droplet, wall smooth, without halo, uniseriate or diagonally arranged in an ascus.

DISTRIBUTION AND HOSTS. – Known from the arctic desert of North America where it was found growing on the thalli of *Candelariella canadensis* and sometimes of neighbouring *Rinodina terrestris*. Pathogenicity including gall-formation was not observed in the material examined.

NOTES. – The ascospores of species of the genus *Lichenochora* Hafellner are typically hyaline but in some species (for example, *L. atrans* Halici, K. Knudsen & Candan or *L. thorii* Zhurb.) they are initially hyaline but later turn medium to dark brown (Hafellner & Navarro-Rosinés 2004, Halici et al. 2009, Zhurbenko 2008). Based on its 4-spored asci and 1-septate ascospores with a length to breadth ratio of less than three *L. arctica* belongs to a group of taxa comprised of *L. aipoliae* Etayo, Nav.-Ros. & Coppins (on *Physcia*), *L. constrictella* (Müll. Arg.) Hafellner (on *Fulgensia*), *L. lecidellae* Boqueras & Nav.-Ros. (on *Lecidella*) and *L. paucispora* Etayo & Nav.-Ros. (on *Bilimbia*) (Etayo & Navarro-Rosinés 2008). All of these species differ from *L. arctica* in their host affiliation and in having ascospores that are either persistently hyaline or initially hyaline but eventually turning light brown (vs. medium brown). Additionally, *L. aipoliae* differs from *L. arctica* in having granulate ascospores and inducing the formation of galls on the host thallus (Etayo & Navarro-Rosinés 2008). *Lichenochora constrictella* and *L. paucispora* differ most noticeably from the new species in having larger ascospores, 20−25 × 8−10 µm and 16−23(−31) × 8−10.5(−12) µm respectively (Etayo & Navarro-Rosinés 2008, Hafellner 1989). Finally, although *L. lecidellae* has ascospores that are comparable in size to those of *L. arctica* it differs in inducing the formation of galls on the thallus of the host (Navarro-Rosinés et al. 1998). The medium brown 1-septate ascospores of *L. arctica* are reminiscent of *Polycoccum* species. However, species of that genus are easily distinguished by different types of asci and paraphyses (Calatayud 2004).

Additional specimen examined. – ERI: 22.vii.2005, on thalli of *Candelariella canadensis* and partly *Rinodina terrestris* growing on mineral soil with plant remnants, *NM* (LE 260874).

***Lichenochora lepidiotae* (Anzi) Etayo & Nav.-Ros.**

NOTES. – To date *Lichenochora lepidiotae* has been reported only from *Fuscopannaria praetermissa* and known in the Arctic only from Iceland (Etayo & Navarro-Rosinés 2008, Svane & Alstrup 2004). Here the species is reported for the first time from North America and also for the first time from the genus *Protopannaria*, another member of the Pannariaceae. The only *Lichenochora* species that has previously been reported from *Protopannaria* is *L. coppinsii* Etayo & Nav.-Ros. That species differs from *L. lepidiotae* in having 2−4-spored asci (vs. 8-spored) and ascospores that are both longer [(50−75 × 5.5−6 µm according to Etayo & Navarro-Rosinés (2008) or (26–)38–56(–62) × (5–)6–7.5(–8) µm, l/b = (4.1–)5.8–8.8(–10.0) according to Zhurbenko (2009b) vs. (24.5−)25−29.5(−33.5) × 4.5−5 µm, l/b = (5.0−)5.4−6.6(−7.4) (n = 13, in water or I)] and have more cells, being (1–)3–9(–12)-septate vs. (0−)1(−5)-septate.

Specimen examined. – ERI: 28.vii.2005, on *Protopannaria pezizoides* (th.), *NM* (LE 260814).

***Lichenochora rinodinae* Zhurb. sp. nov.**

Mycobank #805164.

FIGURE 2.

DIAGNOSIS. – Similar to *Lichenochora lepidiotae*, but with (0−)1-septate vs. (0−)1(−5)-septate ascospores and growing on species of Physciaceae vs. Pannariaceae.

TYPE: **RUSSIA. MURMANSK REGION:** Kola Peninsula, Barents Sea coast, Dal'ne-Zelenetskaya Bay, 69º07'N, 36º05'E, alt. 10 m, dwarf shrub-bryophyte-lichen tundra on coastal terrace, on thallus of *Rinodina mniaraea*, 22.viii.1997, *M. Zhurbenko 97379* (LE 261760, holotype).

DESCRIPTION. – *Vegetative hyphae* hyaline to pale brown, 2.5−5 µm wide, sparingly branched, septate, not or slightly constricted at the septum, immersed. *Ascomata* perithecial, black, glossy, surface distinctly papillate, pyriform, ovoid or subglobose, sometimes plicated above, 125−330 µm diam., with usually indistinct pore to 15 µm diam., ¾ immersed to often almost sessile; the interior filled with numerous lipid droplets, I and K/I−; dispersed to aggregated, sometimes contiguous or fused by 2−4. *Exciple* in surface view of *textura angularis*, of cells 3−22 µm across, with walls 1−3.5 µm thick; in cross

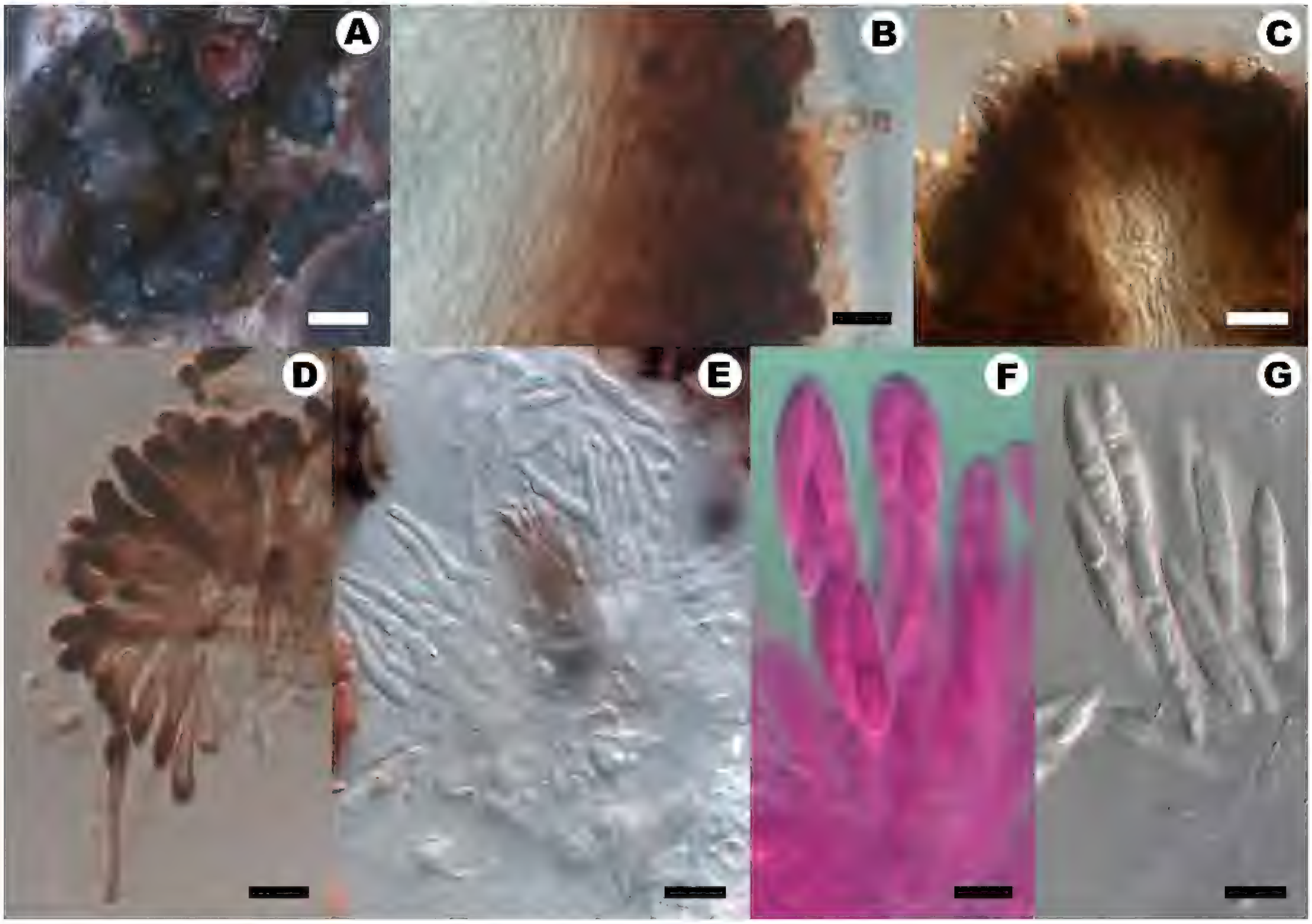

Figure 2, *Lichenochora rinodinae* (all from LE 260760 except for C which is from LE 260664). A, ascomata habitus. B, lateral exciple in cross section (in water). C, ostiolar area in cross section (in I). D, external ostiolar filaments (in K). E, periphyses (in K). F, asci with ascospores (in phloxin). G, ascospores (in K). Scales = 200 µm in A and 10 µm in B-G.

section 40–80 µm thick, inner part of 3–6 layers of hyaline to pale brown cells 8–20 × 1–3 µm with walls 0.5 µm thick; outer part of 8–10 layers of dark brown (K+ olive) pseudoparenchymatous cells 4–11 µm across with 1–2 µm thick walls, outwardly with irregularly swollen papillae 5–18 µm diam. *Periphyses* hyaline, often slightly tapering towards the apices, sometimes branched at the base, 15–30 × 1.5–4 µm, 1–3-septate, guttulate; ostiolar area framed by slightly protruding, brown, non-septate, not branched filaments, 15–30 × 1.5–3.5 µm, with much darker mostly spathulate apices 3–6 µm wide. *Paraphyses* hyaline, septate, usually markedly constricted at the septa, with small and large oil droplets, composed of cells 3–18 µm across, with delicate walls 0.5–1.5 µm thick, evidently disappearing with maturation. *Asci* subcylindrical to narrowly clavate, functionally unitunicate, wall usually not thickened at the apex, (70–)75–87(–92) × (9–)10–14(–17) µm (n = 22, in water, K or phloxin), (4–)8-spored, I and K/I– except cytoplasm becoming yellow-orange. *Ascospores* hyaline, very narrowly ellipsoid to rarely ellipsoid, straight to occasionally somewhat bent, with rather acute, rarely somewhat attenuated ends, (15.0–)24.0–34.8(–45.0) × (3.5–)4.5–5.9(–7.8) µm, l/b = (2.4–)4.4–7.2(–10.0) (n = 373, in water, K or phloxin), (0–)1-septate, not or rarely slightly constricted at the septum, not or only slightly heteropolar, typically with conspicuous lipid droplets, smooth-walled, non-halonate, irregularly biseriate in an ascus.

DISTRIBUTION AND HOST. – Known from the arctic and mountain tundra and arctic desert of Europe, Asia and North America where it was found growing on healthy-looking and damaged apothecia and thalli of *Rinodina mniaraea, R. roscida* and *R. turfacea*. Distinct pathogenicity including gall-formation was not observed.

NOTES. – Among the *Lichenochora* species with 1-septate ascospores of similar size to those of the new taxon, *L. rinodinae* should be compared with *L. elegantis* Hafellner (known from saxicolous specimens of *Xanthoria elegans*), *L. inconspicua* Hafellner (reported from *Bilimbia*, *Lecidea* and *Lecidoma*) and *L. lepidiotae* (reported from species of Pannariaceae) (Etayo & Navarro-Rosinés 2008, Hafellner et al. 2008, Navarro-Rosinés et al. 1998, Zhurbenko 2009b, Zhurbenko & Thor 2013). All three of these species have a different host selection, while *Lichenochora* species are usually specific to a particular host genus (Lawrey & Diederich 2011). *Lichenochora elegantis* differs from the new species in having often 4-spored asci [vs. (4-)8-spored asci], while *L. inconspicua* has ascospores that are mainly 5.5−7 µm wide (vs. mainly 4.5−5.9 µm). *Lichenochroa lepidiotae* has (0−)1(−5)-septate ascospores. The only other *Lichenochora* species that has been found on *Rinodina* to date is the unidentified one referred to as "*Lichenochora* sp." that is presented below. That taxon is distinct from *L. rinodinae* in having much shorter and somewhat wider ascospores.

Additional specimens examined (all on healthy-looking or sometimes damaged thalli and apothecia of Rinodina species). – **U.S.A. ALASKA:** Barter Island, 70°08'N, 143°37'W, dwarf shrub-lichen tundra, 10.viii.1994, on *R. turfacea*, *DW* (LE 260819). **CANADA. NORTHWEST TERRITORIES:** Amund Ringnes Island, 78°25'N, 96°45'W, alt. 20 m, arctic desert, polygonal barren, 2.viii.1999, on *R. turfacea*, *NM* (LE 261540); ERI: on *R. turfacea*, 23.vii.2005, *NM* (LE 260664); 28.vii.2005, on *R. turfacea*, *NM* (LE 260684). **NORWAY. SVALBARD:** Dickson Land, W coast of Billefjorden, 5 km S of Pyramiden settlement, N foot slope of the mountain Garmaksla, 78°37'N, 16°20'E, alt. 100 m, tundra, 23.vii.2003, on *R. turfacea*, *M. Zhurbenko 03296* (LE 260839); Bünsow Land, NE extremity of Billefjorden near Kapp Napier, 8 km E of Pyramiden settlement, 2 km SW of Nordenskiöldbreen glacier, depression with Norddammen Lake, 78°38'N, 16°44'E, alt. 10 m, tundra, 21.vii.2003, on *R. roscida*, *M. Zhurbenko 03350* (LE 260970a). **RUSSIA. FRANZ JOSEF LAND:** Alger Island, 80°25'N, 56°00'E, alt. 50 m, arctic desert, 1.viii.1930, on *R. mniaraea*, *V.P. Savicz 1842* (LE 207136); Hooker Island, Cape Sedov, 80°20'N, 53°00'E, arctic desert, 26.vii.1930, on *R. turfacea*, *V.P. Savicz 1415* (LE 207135). **POLAR URAL:** 50 km SSE of Vorkuta, near 61 km of the railway Vorkuta-Labytnangi, 67°02'N, 64°26'E, alt. 100 m, mountain shrub tundra, 29.vi.1993, on *R. turfacea* partly possibly fused with *Lecanora epibryon*, *M. Zhurbenko 93189* (LE 261610); NE slope of Rai-Iz Mountain, 66°56'N, 65°35'E, alt. 600 m, mountain tundra, 26.vi.1993, on *R. turfacea*, *M. Zhurbenko 9355* (LE 260710). **CENTRAL SIBERIA:** Severnaya Zemlya Archipelago, Bol'shevik Island, Skalistaya River at 20 km E of Cape Antseva, 78°15'N, 103°30'E, alt. 50 m, arctic desert, 25.viii.1998, on *R. turfacea*, *NM* (LE 260760); E coast of Shokal'skogo Strait, 1 km SE of Mys Baranova polar station, 79°16'N, 101°40'E, alt. 20 m, artic desert, 15.vii.1996, on *R. roscida*, *M. Zhurbenko 961007* (LE 260031); 13.vii.1996, on *R. mniaraea*, *M. Zhurbenko 961008a* (LE 260141a) [associated with *Polycoccum bryonthae* (Arnold) Vězda (LE 260141b), growing on damaged and healthy-looking thallus and apothecia of *R. mniaraea*[2]]; W coast of Mikoyana Bay, 79°18'N, 101°55'E, alt. 10 m, arctic desert, 21.vii.1996, on *R. mniaraea*, *M. Zhurbenko 961006* (LE 260022); Taimyr Peninsula, Byrranga Mountains, NW of Levinson-Lessinga Lake, 74°31'N, 98°27'E, alt. 450 m, tundra, 10.viii.1995, on *R. turfacea*, *M. Zhurbenko 95518* (LE 260291). **YAKUTIYA:** Lena River delta, left bank of Bol'shaya Tumatskaya Channel, Amerika-Khaya nunatak, 72°35'N, 126°18'E, alt. 50 m, tundra, 30.vii.1998, on *R. turfacea*, *M. Zhurbenko 98387* (LE 261800). **CHUKOTKA:** Iskaten' Range at 32 km Egvekinot-Iul'tin road, 66°35'N, 179°10'W, tundra, 20.vii.1971, on *R. turfacea*, *A. Katenin* (LE 260799).

***Lichenochora* sp.**

NOTES. – The material examined for this study and cited below is similar to *Lichenochora inconspicua*, a species that has been reported from *Bilimbia*, *Lecidea* and *Lecidoma* (see the previous entry). However, the ascospores of that species have been reported longer [(19−)20.5−35(−39) × 6−7.5(−9) µm, l/b = (2.9−)3.3−5.0(−5.7) according to Navarro-Rosinés et al. (1998) or (18−)19.5−23(−25.5) × (4.5−)5.5−7.5(−8.5) µm, l/b = (2.6−)2.9−3.9(−4.5) according to Zhurbenko & Thor (2013)] than those observed in the present material [(12.5−)14.5−21(−28) × (4.5−)5.5−7(−7.5) µm, l/b = (1.8−)2.2−3.6(−5.2) (n = 68)]. As is the case for *L. inconspicua* the collection cited below has asci that are (4−)8-spored and ascospores that are ellipsoid to narrowly ellipsoid, (0−)1-septate and not constricted at the septum.

Specimens examined. – ERI: 28.vii.2005, on thalli of *Rinodina turfacea* (main host) and closely adjacent *Caloplaca ammiospila*, *NM* (LE 260724A, LE 260724B).

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[2] Note that this is the first report of *Polycoccum bryonthae* from the host *Rinodina mniaraea*.

Lichenoconium pyxidatae (Oudem.) Petr. & Syd.

CHARACTERIZATION OF THE MATERIAL. – Pycnidia 100–150 µm diam. Conidia mostly obovoid, sometimes subglobose or ellipsoid, often tapered or occasionally strongly attenuated below, usually distinctly truncated at the base, pale to medium brown, walls appearing smooth at light microscopy, (2.4–)2.9–3.7(–4.3) × (2.0–)2.1–2.5(–2.8) µm, l/b = (1.0–)1.2–1.6(–2.0) (n = 49).

NOTE. – The species is widely distributed in the Holarctic (Hawksworth 1981), but still newly reported from Canada.

Specimen examined. – ERI: 25.vii.2005, on *Cladonia pyxidata* (cups), *NM* (LE 260886).

Lichenodiplis lecanorae (Vouaux) Dyko & D. Hawksw.

NOTES. – Hawksworth & Dyko (1979) reported conidia of this species being 4–7.5 × 2–3 µm; in the specimen examined they measure (5–)6–7.5(–9) × (2.5–)3–3.5(–4.5) µm, l/b = (1.4–)1.8–2.6(–3.6) (n = 57, in K). The collection cited below is the first report of this species from the American Arctic, excluding Greenland where it was reported, for example, by Alstrup and Hawksworth (1990). *Pertusaria octomela* is a new host species for the taxon.

Specimen examined. – ERI: 26.vii.2005, on *Pertusaria octomela* (th., including fertile verrucae), *NM* (LE 260665).

Llimoniella catapyrenii Zhurb., Kukwa & Flakus sp. nov.

Mycobank #805165.

FIGURE 3.

DIAGNOSIS. – Similar to *Llimoniella placopsidis*, but with longer ascospores, (9.5–)11.5–15.5(–18.5) × 2.5–3.5(–4) µm vs. 9–12 × 2.5–3 µm, and growing on species of *Catapyrenium* vs. *Placopsis*.

TYPE: CANADA. NORTHWEST TERRITORIES: Ellef Ringnes Island, Isachsen Bay, 78°47'N, 103°32'W, alt. 30 m, arctic desert, on squamules of *Catapyrenium cinereum*, 24.vii.2005, *N. Matveeva s.n.* (LE 260675, holotype).

DESCRIPTION. – *Ascomata* evenly dark brown to blackish, glossy, with rough surface, roundish to somewhat elongate in surface view, superficial, often constricted at the base, (50–)120–300 µm diam., with a flat to concave disc, surrounded by a distinct, usually prominent, sometimes uneven and/or cracked margin 30–60 µm thick, dispersed to aggregated or confluent. *Exciple* cupulate, entirely dark orange-brown, 30–50 µm thick, in cross section mainly of thick-walled isodiametric cells 4–10 µm diam., without hairs. *Epihymenium* medium orange-brown, 10–20 µm tall. *Hymenuim* hyaline, 40–50 µm tall, not inspersed, I and K/I–. Epihymenial and excipular pigments amorphous reddish or orange brown, K+ fleetingly violet/purplish and then purplish, reddish or vinaceous brown, N+ brighter orange-brown. *Paraphyses* 1.5–2.5 µm wide, sometimes thickened at the apices up to 4 µm, occasionally dichotomously branched, septate with interstices mainly 10–20 µm long. *Subhymenium* hyaline, indistinct. *Asci* subcylindrical, with wall 0.5–0.7 µm thick laterally and 0.5–1.2 µm apically, with rounded apex and short foot, without ocular chamber, (41–)42–50(–60) × (7–)8–10 µm (n = 25, in water, K or K/I), I and K/I–, 8-spored. *Ascospores* hyaline, narrowly ellipsoid or narrowly oblong, straight or slightly curved, (9.5–)11.5–15.5(–18.5) × 2.5–3.5(–4) µm, l/b = (3.1–)3.7–5.5(–6.8) (n = 45, in K/I, K or water), 0(–1)-septate, wall smooth, ca. 0.3 µm thick, without perispore, often with 2–5 large lipid guttules, diagonally uniseriate, irregularly biseriate or in fascicles by 3–4 in an ascus. *Conidiomata* unknown.

DISTRIBUTION AND HOST. – Known from the arctic desert of North America and subnival mountain vegetation belt in Central Europe, where it was found growing on the upper surface and edges of *Catapyrenium* squamules. Pathogenicity was not observed.

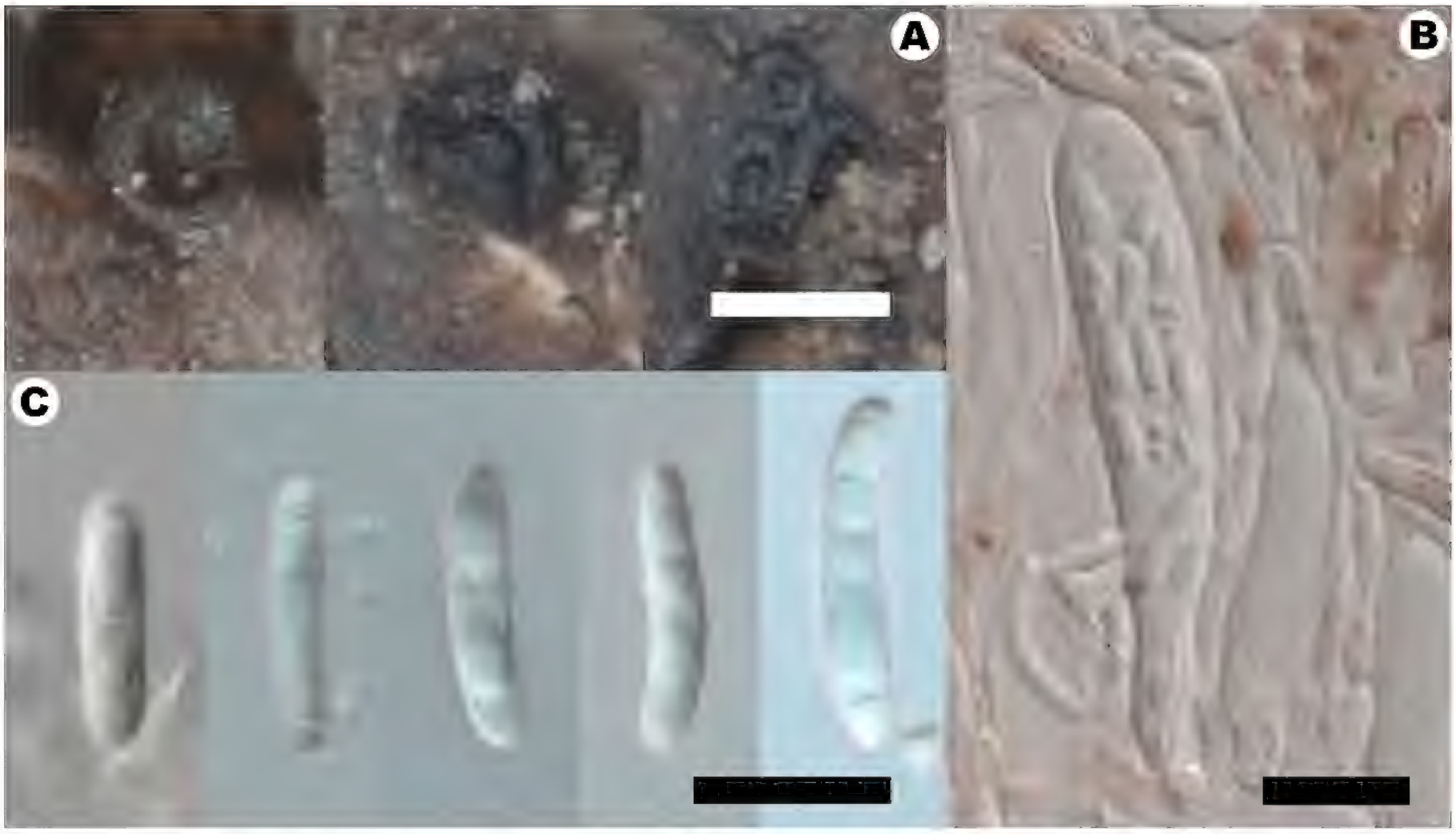

Figure 3, *Llimoniella catapyrenii* (all from the holotype). A, ascomata habitus. B, asci and paraphyses (in K). C, ascospores (in water). Scales = 200 µm in A and 10 µm in B and C.

NOTES. – *Llimoniella catapyrenii* was first recognized by Kukwa and Flakus (2009), who reported it from the Polish mountains as *L.* cf. *adnata* Hafellner & Nav.-Ros. According to Diederich et al. (2010) it belongs to the group of *Llimoniella* species with a distinct K+ reaction of the epihymenial and excipular pigments. Within this group it is most similar to *L. placopsidis* Diederich & Fryday, which grows on *Placopsis* (Agyriaceae, Agyriales), and to *L. adnata*, which inhabits *Placidium* species that are macroscopically similar to *Catapyrenium* and also belong to the Verrucariaceae (Diederich & Etayo 2000, Diederich et al. 2010, Hafellner & Navarro-Rosinés 1993). *Llimoniella placopsidis* can be distinguished from *L. catapyrenii* by its shorter ascospores, measuring 9–12 × 2.5–3 µm, and different host selection. *Llimoniella adnata* differs from the new species by its larger ascomata (200–500 µm diam.), taller hymenium (100–120 µm tall), longer asci (80–90 × 8–9 µm) and by much wider and less elongated ascospores [(9–)11–13 × (5–)6–7 µm, l/b = 1.9]. It is noteworthy that 14 of 16 previously known *Llimoniella* species are confined to a particular host genus (Lawrey & Diederich 2011).

Additional specimens examined (both in subnival belt on terricolous Catapyrenium sp.). – **POLAND. HIGH TATRA MOUNTAINS:** Przelaczka pod Zadnim Mnichem Pass, 49°11'19"N, 20°03'06"E, alt. 2135 m, 15.viii.2004, *A. Flakus 3094* (KRAM); Hinczowa Przelecz pass, 49°11'16"N, 20°03'19"E, alt. 2323 m, 1.viii.2003, *A. Flakus 1139* (KRAM).

***Merismatium heterophractum* (Nyl.) Vouaux**

NOTES. – The material matches well the description published by Triebel (1989) in having ascomata (50–)75–100(–125) µm in diameter and ascospores that are initially hyaline then pale brown, with walls and septa that are darker than the contents of the cells. The ascospores are, however, somewhat narrower than those reported in Triebel (1989), viz. (6.5–)9.4–12.4(–16.0) × (3.5–)4.2–5.2(–6.5) µm, l/b = (1.4–)2.0–2.6(–3.3) (n = 172, in water or I) vs. (8–)10–13(–16) × (4–)5–6.5(–7.5) µm. The collections cited below extend the distribution of *Merismatium heterophractum* into Canada and the American Arctic, excluding Greenland where it was reported, for example, by Alstrup et al. (2000).

Specimens examined. – ERI: 22.vii.2005, on *Buellia insignis* (th.), *NM* (LE 260851), 24.vii.2005, *NM* (LE 260834a), 26.vii.2005, *NM* (LE 260884, LE 260854b, LE 260744), 28.vii.2005, *NM* (LE 260764), 30.vii.2005, *DW* (LE 260864b); 22.vii.2005, on *Lecidella wulfenii* (th.), *NM* (LE 260379); 23.vii.2005, *NM* (LE 260645); 24.vii.2005, on adjacent *Buellia insignis* and *Rinodina turfacea* (th., degraded ap.), *NM* (LE

260811); 28.vii.2005, on *R. turfacea* (th.), *NM* (LE 260724c); 23.vii.2005, on undentified crustose lichens on soil (th.), *NM* (LE 260634), 24.vii.2005, *NM* (LE 260654).

***Merismatium* cf. *nigritellum* (Nyl.) Vouaux**

CHARACTERIZATION OF THE MATERIAL. – Ascomata (75–)100–150(–200) µm diam. Ascospores initially hyaline, then pale brown, walls and septa darker than content, mostly broadly to narrowly ellipsoid, occasionally narrowly obovoid or subglobose, sometimes with acute or slightly attenuated ends, (11–)14.5–19.5(–22.5) × (6–)7–9(–10) µm, l/b = (1.2–)1.7–2.5(–3.5) (n = 97), mostly with 3–7 trans- or oblique septa and one longiseptum in central segments, rarely 0–1-septate.

NOTES. – According to Triebel (1989) the ascomata and ascospores of the species are somewhat larger than those reported here, viz. (150–)200–250(–300) µm diam. and (14–)15–24.5(–32) × (6.5–)8–12(–15) µm respectively. Nonetheless the edges of the size ranges overlap between the specimens cited here and those published in the literature. So far this species has not been documented from Canada and American Arctic, except Greenland where it was reported, for example, by Alstrup and Hawksworth (1990).

Specimens examined. – ERI: 26.vii.2005, on thalli of *Bryonora castanea* and adjacent unidentified crustose lichens on soil, *DW* (LE 260625); 25.vii.2005, on *Cladonia pyxidata* (more or less moribund basal squamules), *NM* (LE 260826); 25.vii.2005, on *Protopannaria pezizoides* (prothallus), *DW* (LE 260804); 28.vii.2005, on thalli of unidentified crustose lichens on soil, *NM* (LE 260784a).

***Minutoexcipula mariana* V. Atienza**

CHARACTERIZATION OF THE MATERIAL. – Conidiomata sporodochia-like, concave, 50–120 µm diam. Conidiophores unbranched or occasionally 2(–3)-branched, 8–13 × 2–2.5 µm. Conidia initially hyaline, then pale to medium brown, walls and septa darker than content, (4.5–)6–8(–9.5) × (2.5–)3–4(–5.5) µm, l/b = (1.3–)1.8–2.6(–3.2) (n = 78), (0–)1-septate, not or rarely slightly constricted at the septum.

NOTES. – *Pertusaria glomerata* is here reported as a new host species for *Minutoexcipula mariana*. The species is also documented for the first time from Canada and the Arctic.

Specimen examined. – ERI: 24.vii.2005, on *Pertusaria glomerata* (th. and fertile verrucae), *NM* (LE 260685b).

***Muellerella erratica* (A. Massal.) Hafellner & Volk. John**

NOTES. – The collection cited below fits well the description published by Triebel (1989) in having ascomata 150–200(–300) µm in diameter, ascospores that are pale to medium olive brown, (0–)1-septate, not or slightly constricted at the septum, thin-walled and no less than 64 per ascus. Nonetheless the ascospores are somewhat narrower than was reported for the species by Triebel (1989) [(4.5–)5.5–7(–8.5) × (2–)2.5–3(–3.5) µm, l/b = (1.6–)2.1–2.9(–3.4) (n = 56) vs. (5.5–)6–8(–8.5) × (2.5–)3–4.5(–5) µm)].

Specimen examined. – ERI: 22.vii.2005, on *Lecidea confluens* (th., occasionally ap.: hymenium), *NM* (LE 260725).

***Muellerella lichenicola* (Sommerf.) D. Hawksw.**

NOTES. – This taxon is one of the most common species of lichenicolous fungi, with a wide host range and cosmopolitan distribution. It was previously reported from Canada by Alstrup and Cole (1998), Kondratyuk and Kudratov (2002) and Zhurbenko (2009b).

Specimen examined. – ERI: 24.vii.2005, on *Pertusaria glomerata* (th. and fertile verrucae), *NM* (LE 260685a).

***Opegrapha buelliae* Zhurb. sp. nov.**

Mycobank #805166.

FIGURE 4.

DIAGNOSIS. – Similar to *Opegrapha thelotrematis*, but with rounded to irregularly oblong-ellipsoid ascomata, sometimes widely exposed discs and K– exciple.

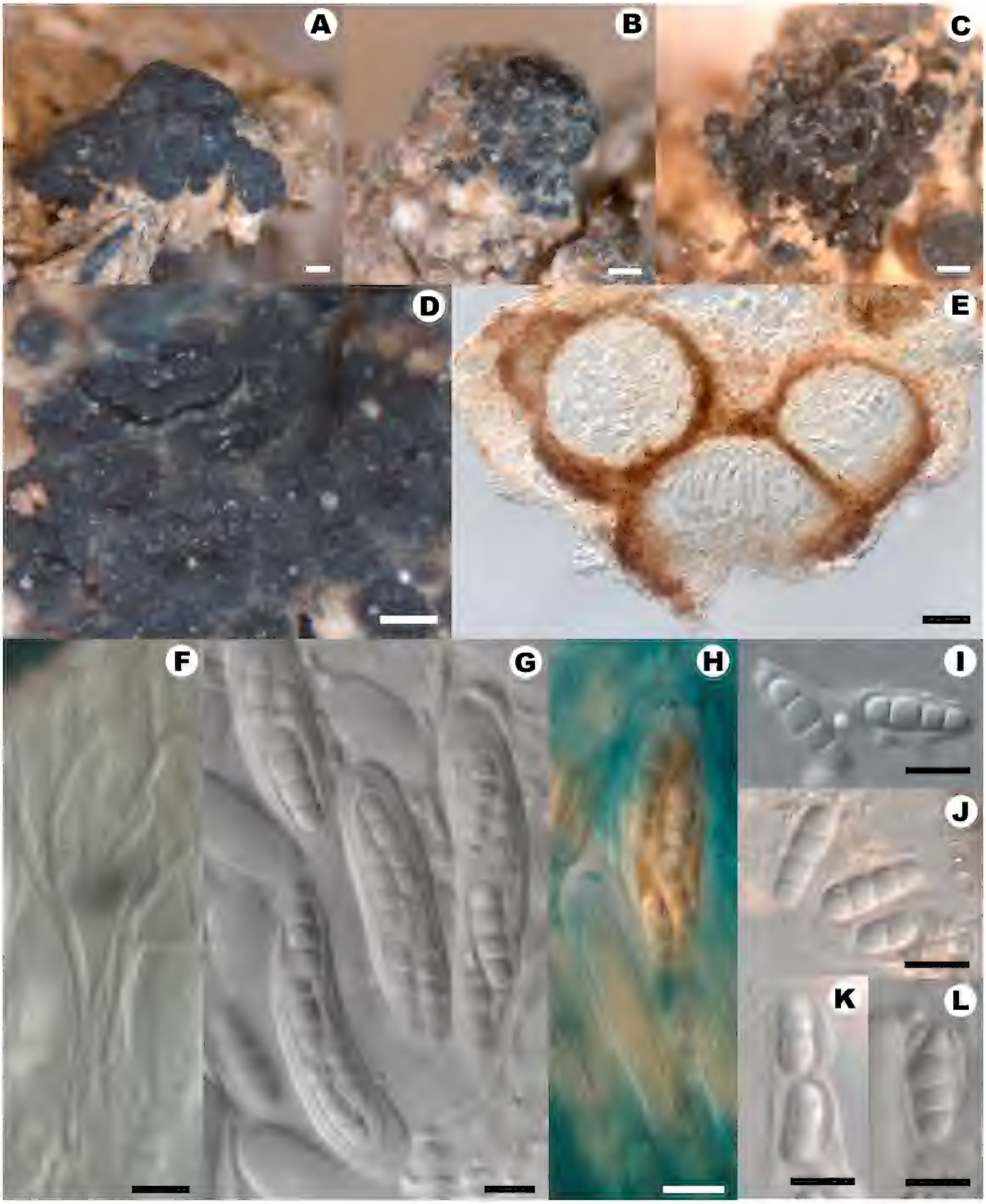

Figure 4, *Opegrapha buelliae* (A, C, D-F and J from LE 260754; B, G, H, K and L from LE 260864a). A, ascomata fused in stromatic swelling. B and C, clustered ascomata interspersed with remnants of host thallus. D, mature ascomata with exposed discs. E, confluent ascomata in cross section (in water). F, interascal filaments (in K). G, asci with ascospores (in K). H, asci with ascospores (in K/I). I and J, ascospores (in water). K and L, ascospores (in K). Scales = 200 µm in A-C; 100 µm in D, 20 µm in E and 10 µm in F-L.

TYPE: CANADA. NORTHWEST TERRITORIES: Ellef Ringnes Island, Isachsen Bay, 78°47'N, 103°37'W, alt. 35 m, arctic desert, polygonal barren, on thallus of *Buellia insignis*, 30.vii.2005, *D. Walker s.n.* (LE 260864a, holotype).

DESCRIPTION. – *Ascomata* subglobose, urceolate or cup-shaped (often flattened at the bottom), 80–400 µm diam., up to 200 µm tall, at first completely immersed and closed, later more or less protruding, rounded to irregularly oblong-ellipsoid (sometimes contorted) in surface view, with punctiform, slit-like or rather widely exposed, blackish, glossy, epruinose, flat to concave disc, sometimes surrounded by a raised, black exciple, occasionally with radial slits; often confluent, aggregated by up to 100 in black stromatic swellings (sometimes including remnants of host thallus) up to 3 mm across and up to 1 mm tall. *Exciple* dark brown, sometimes above with olive or vinaceous grey tinge better seen in K, continuous under the hypothecium; 10–30 µm wide basally and laterally, 30–50(–80) µm wide above; in cross section of rounded or elongated thick-walled cells 3–11 µm across or partly above of hyphae 2.5–4.5 µm wide, K–, here and there merging with the concolorous pseudoparenchymatous stroma. *Epithecium* hyaline or in exposed parts olive brown. *Hymenium* hyaline, 50–70 µm tall; hymenial gel I+ blue then quickly turning reddish brown, K/I+ blue. *Hypothecium* hyaline to pale olive brown, 10–20 µm tall, sometimes indistinct, K–. *Interascal filaments* sparingly branched and septate, 1.5–3 µm wide, with non-swollen apices. *Asci* bitunicate, cylindrical-clavate, with short foot, thick-walled, (41–)46–62(–70) × (10–)11–13(–15) µm (n = 17, in water, K or K/I), I and K/I– except for a conspicuous K/I+ blue ring around the apex of the ocular chamber, (4–)8-spored. *Ascospores* hyaline, narrowly clavate or occasionally narrowly oblong, usually with rounded ends, (12.5–)14.4–17.6(–20.0) × (3.5–)4.3–5.5(–6.3) µm, l/b = (2.0–)2.7–3.7(–4.9) (n = 110, in water, I or K), (2–)3-septate, markedly constricted at the septa (particularly in K), usually with distinct hyaline smooth perispore 0.5–2 µm thick, I and K/I–, more or less biseriate in an ascus. *Conidiomata* pycnidial, immersed. *Conidiogenous cells* subcylindrical, enteroblastic, acrogenous. *Conidia* hyaline, non-septate, bacilliform to fusiform, (3.8–)3.9–4.9(–5.5) × (1.1–)1.2–1.4 µm (n = 10, in K).

DISTRIBUTION AND HOSTS. – Known from the arctic desert of North America where it was found growing on thalli of *Buellia insignis*. Pathogenicity was not observed.

NOTES. – Amongst the lichenicolous species of *Opegrapha* and their allied species, *O. buelliae* closely resembles *Phacothecium varium* (Tul.) Trevis. (syn. *O. physciaria* (Nyl.) D. Hawksw. & Coppins, which grows on *Xanthoria parietina* (L.) Th. Fr. group spp.) and *O. thelotrematis* Coppins (which grows on *Thelotrema* spp.), these also have densely clustered ascomata. However, the former species clearly differs from *Opegrapha buelliae* in its asci without a K/I+ blue apical ring and the presence of a dark brown perispore of over-mature ascospores (Ertz & Egea 2007). The latter species differs from *Opegrapha buelliae* in its lirellate ascomata with persistently slit-like discs and a K+ greenish exciple (Coppins 1987). The ascomata of *Opegrapha buelliae* sometimes look perithecial. This feature is also characteristic for *O. reactiva* (Alstrup & D. Hawksw.) Etayo & Diederich (syn. *Kalaallia reactiva* Alstrup & D. Hawksw.) and led to the description of a monotypic genus *Kalaallia* Alstrup & D. Hawksw. (Alstrup & Hawksworth 1990), which was later reduced into synonymy with *Opegrapha* (Etayo & Sancho 2008). *Opegrapha reactiva* (which grows on *Bellemerea* and *Ionaspis* species) differs from *O. buelliae* in its loosely aggregated ascomata up to 100 µm in diameter, I+ pale blue hymenium and larger ascospores measuring (17.5–)20–24 × 5–7 µm. Most lichenicolous *Opegrapha* species are now treated as specific to a single host genus, and none have so far been reported on *Buellia* (Lawrey & Diederich 2011).

Additional specimens examined. Both on Buellia insignis (th.). – ERI: 23.vii.2005, *NM* (LE 260824); 24.vii.2005, *NM* (LE 260754).

***Phaeosporobolus alpinus* R. Sant., Alstrup & D. Hawksw.**

NOTES. – This species is one of the most common in the Arctic lichenicolous fungi, mainly growing on *Ochrolechia* and *Pertusaria* species. It was previously reported from Canada by Alstrup and Cole (1998), Diederich (2003) and Zhurbenko and Daniëls (2003).

Specimens examined. – ERI: 24.vii.2005, on *Ochrolechia* cf. *androgyna* (th.), *NM* (LE 260821); 25.vii.2005, on *Pertusaria dactylina* (th.), *NM* (LE 260399).

Pronectria walkerorum **Zhurb.**

NOTES. – Analysis of new and previously known specimens of the species has resulted in a refined understanding of the sizes of its asci and ascospores. Based on the specimens cited below the asci measure (70−)85−117(−130) × (7−)8−12(−13) µm (n = 27, in water or cotton blue) and the ascospores measure (8−)12−16(−20) × (4−)5.5−8.5(−10) µm, l/b = (0.9−)1.4−2.6(−4.3) (n = 368, in water or cotton blue).

Specimens examined. – ERI: 22.vii.2005, on *Ochrolechia* cf. *inaequatula* (th.), *NM* (LE 260861), 25.vii.2005, *DW* (LE 260831); 23.vii.2005, on terricolous *Ochrolechia* sp. (th.), *NM* (LE 260871).

Additional previously published specimens examined for comparison. − PPI: 24.vii.2004, on terricolous *Ochrolechia* sp. (th.), *DW* (LE 210371, holotype). **U.S.A. ALASKA:** Howe Island, 3.viii.2003, on *Ochrolechia* sp. (th.) growing on moss remnants, *DW* (LE 210381); 140 km E of Kotzebue, Kobuk River near junction with Kavet Creek, 9.viii.2000, on *O. androgyna* (th.), *M. Zhurbenko 00458* (LE 210391); Prudhoe Bay, Deadhorse, 2.vii.2002, on *Ochrolechia* sp. (th.) growing on mossy soil, *DW* (LE 232888). **RUSSIA. Yakutiya:** Lena River delta, Stolb Island, 12.viii.1998, on *Ochrolechia frigida* (th.), *M. Zhurbenko* (LE 233629).

Pseudopyrenidium tartaricola **(Lindsay) Nav.–Ros., Zhurb. & Cl. Roux**

NOTE. – *Pseudopyrenidium tartaricola* is here reported as new to Canada and American Arctic, excluding Greenland where it was reported, for example, by Alstrup and Hawksworth (1990).

Specimens examined. – ERI: on *Ochrolechia* cf. *inaequatula* (th.), 24.vii.2005, *NM* (LE 260612); on *Ochrolechia* sp. (th.), 22.vii.2005, *NM* (LE 260389).

Scutula cladoniicola **Alstrup & D. Hawksw.**

CHARACTERIZATION OF THE MATERIAL. – Apothecia initially dark brown then black, glossy, disc flat to concave, with persistent thin margin, 75−250 µm diam. Hymenium I and K/I+ dark blue above, I+ red and K/I+ blue below. Paraphyses often markedly constricted at the septa, with interstices between septa mainly 4−7 µm long. Ascospores narrowly obovoid with rounded ends, hyaline, (9−)10.5−12(−13.5) × 3.5−4.5(−5.5) µm, l/b = (1.8−)2.4−3.2(−3.4) (n = 35) [in the protologue their size is given as (12.5−)13−15(−16) × 5−6.5 µm (Alstrup & Hawksworth 1990)], smooth-walled, non-halonate, (0−)1-septate, not or rarely slightly constricted at the septum, sometimes with many distinct guttules.

Specimen examined. – **CANADA. NORTHWEST TERRITORIES:** 40 km S of Inuvik, near Dempster Highway, 68°06'39"N, 133°28'38"W, lichen-dwarf shrub-*Picea mariana* forest-tundra, 14.vii.2004, on *Cladonia stygia* (moribund bases of podetia), *DW* (LE 260705).

Skyttea dacampiae **Zhurb.**

NOTES. – In the specimen cited below the ascospores measure (6−)6.5−8.5(−10) × 2.5−3 µm with a length to breadth ratio of (2.0−)2.5−3.3(−4.0) (n = 33) [in the protologue their size is given as (7−)7.5−10(−11) × 2−2.5 µm, l/b = 3.2−5.1(−5.5) (Zhurbenko 2007)], and the excipular hairs are 35−43 × 2.5−3.5 µm. The species was described as occurring on the thallus of *Dacampia hookeri* growing in mountain tundra and was so far known only from the type collection made in northern Norway (Zhurbenko 2007). According to Lawrey & Diederich (2011) all 26 currently recognized lichenicolous *Skyttea* species are confined to a particular host lichen genus. However, apart growing on a different host genus, the specimen examined fits very well the species protologue, thus *Lecidella* is suggested as a new host genus for the taxon and this is its first report from North America and the Arctic.

Specimen examined. – ERI: 22.vii.2005, on *Lecidella wulfenii* (th.), *NM* (LE 260704).

Sphaerellothecium araneosum **(Arnold) Zopf**

NOTES. – This is a common lichenicolous fungus in the Arctic, mainly growing on *Ochrolechia* species. Previously it was reported from Canada by Goward et al. (1994) and Alstrup and Cole (1998).

Specimen examined. – ERI: 25.vii.2005, on *Pertusaria dactylina* (th.), *NM* (LE 260805).

Sphaerellothecium cladoniae **(Alstrup & Zhurb.) Hafellner**

NOTE. – In the specimens cited below the infection of the lichenicolous fungus causes strong bleaching of the host thalli.

Specimens examined. – ERI: 20.vii.2005, on *Cladonia pocillum* (mainly basal squamules, occasionally podetia), *NM* (LE 260825). PPI: 21.vii.2004, on *C. pocillum* (basal squamules), *DW* (LE 260835).

***Sphaerellothecium minutum* Hafellner**

NOTES. – *Sphaerellothecium minutum* is common in the Arctic where it occurs on *Sphaerophorus* species. The species was previously reported from Canada by Hafellner (1993).

Specimen examined. – ERI: 24.vii.2005, on *Sphaerophorus globosus* (moribund parts of th.), *NM* (LE 260815).

***Stigmidium mitchellii* Cl. Roux & Bricaud**

NOTES. – The specimens cited below represent the first reports of this species from North America, excluding Greenland where it was reported by Alstrup et al. (2009). This is also the first report of the species from the host genus *Fuscopannaria*.

Specimens examined. – ERI: 22.vii.2005, on *Fuscopannaria praetermissa* (th.), *NM* (LE 260774); 23.vii.2005, on *Psoroma hypnorum* (ap.: disc, margins; th.), *NM* (LE 261190).

***Stigmidium peltideae* (Vain.) R. Sant.**

CHARACTERIZATION OF THE MATERIAL. – Ascomata (30–)50(–70) µm diam., mostly semi-immersed, dispersed. Asci (27–)29–37(–41) × (10–)11–15(–18) µm (n = 33, in BCr or water). Ascospores hyaline, (8.5–)11–13(–14) × 3.5–4(–5) µm, l/b = (2.1–)2.5–3.3(–3.7) (n = 113, in BCr or water), often pseudotetrablastic, 1-septate, not or slightly constricted at the septum, non-halonate. Walls of asci and ascospores BCr+ violet. Pathogenicity not observed, but ascomata often located on old or moribund parts of host lobes.

NOTES. – This rather common species was so far known from many reports on various *Peltigera* species and also from single reports on *Solorina* (Suija 2005) and *Pseudocyphellaria* (Kondratyuk & Galloway 1995), but not *Sticta*. *Stigmidium cupulare* (Pat.) D. Hawksw., the only *Stigmidium* species previously known on *Sticta*, has much large ascomata, measuring 200–400 µm in diameter, and is known only from China and Japan (Clauzade et al. 1989, Saccardo 1905).

Specimens examined. – ERI: 24.vii.2005, on *Peltigera canina* (th.), *NM* (LE-260775); 28.vii.2005, on *P. frippii* (th., including underside of lobe margins), *NM* (LE 260765); 23.vii.2005, on *P. leucophlebia* (th.), *NM* (LE 260745), 24.vii.2005, *NM* (LE 260755); 28.vii.2005, on *P. rufescens* (th.), *NM* (LE 260785); 26.vii.2005, on *Sticta arctica* (th.), *NM* (LE 260795).

***Taeniolella rolfii* Diederich & Zhurb.**

NOTES. – The species is known from the Holarctic growing on *Cetraria* and *Cetrariella* species. It was previously reported from Canada by Diederich and Zhurbenko (2001).

Specimen examined. – ERI: on *Cetraria islandica* (lobe margins), 24.vii.2005, *NM* (LE 232920).

^{L} *Thelocarpon epibolum* Nyl.

NOTES. – This is a scarcely lichenized fungus mostly growing on lichens. The specimen cited below is the first report for the American Arctic, excluding Greenland where it was reported, for example, by Alstrup and Hawksworth (1990).

Specimen examined. – ERI: 20.vii.2005, on *Peltigera leucophlebia* (th.), *NM* (LE 260895b).

***Xenonectriella lutescens* (Arnold) Weese**

NOTE. – Known from sporadic finds in the Holarctic mainly on *Solorina* species this taxon was previously reported from Canada by Zhurbenko (2009b).

Specimen examined. – ERI: 23.vii.2005, on *Peltigera* cf. *canina* (upper side of lobes), *NM* (LE 260841).

***Zwackhiomyces berengerianus* (Arnold) Grube & Triebel**

NOTE. – The species is rather common in the Holarctic (Grube & Hafellner 1990, Zhurbenko et al. 1995, Zhurbenko 2009a), but still new to Canada.

Specimen examined. – PPI: 23.vii.2004, on *Mycobilimbia carneoalbida* (th.), *DW* (LE 260674).

***Zwackhiomyces macrosporus* Alstrup & Olech**

CHARACTERIZATION OF THE MATERIAL. – Ascomata 150–250 µm diam., semi-immersed to almost superficial. Asci 105–130 × 15–16 µm (n = 6, in I). Ascospores hyaline, narrowly oblanceolate with rather acute ends, (0−)1-septate, not or slightly constricted at the septum, typically with the upper cell much wider and 1.5 times longer than the lower one, (24.5−)28.7−36.5(−45) × (6.5−)7.3−9.5(−12.0) µm, l/b = (2.7−)3.3−4.5(−5.2) (n = 44, in water or I), verruculose. Pathogenicity not observed.

NOTES. – The species was previously known only from two arctic regions (Svalbard and Chukotka) (Alstrup & Olech 1993, Zhurbenko 2009a). This is the first report of *Zwackhiomyces macrosporus* from North America and also from the host genus *Fuscopannaria*.

Specimen examined. – ERI: 23.vii.2005, on *Fuscopannaria praetermissa* (prothallus and th.), *NM* (LE 260735).

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Lichens of the Bruce Peninsula, Ontario: Results from the 17th Tuckerman Workshop, 18-22 Sept. 2008

IRWIN M. BRODO[1], RICHARD C. HARRIS[2], WILLIAM BUCK[3], JAMES C. LENDEMER[4], CHRIS LEWIS[5],

ABSTRACT. – An inventory of the lichens of Bruce Peninsula National Park and Fathom Five National Marine Park in the Georgian Bay area of southern Ontario was carried out by 30 lichenologists participating in the 2008 Tuckerman Workshop. A list of 370 species of lichens, related fungi and lichenicolous fungi was compiled, documenting that the parks are remarkably rich in lichens, including many rarities. Following the park inventory, an additional 21 lichens from Bruce County are listed based on the published literature and other recent collections. Twelve lichens, one related fungus and nine lichenicolous fungi are additions to the Canadian lichen flora: *Acarospora moenium*, *Bagliettoa baldensis*, *Biatora ocelliformis*, *Caloplaca flavocitrina, Clavascidium umbrinum, Dermatocarpon dolomiticum, D. muhlenbergii*, *Heppia adglutinata*, *Lecania cuprea, Opegrapha mougeotii, Thelidium minutulum*, *Heteroplacidium compactum*; *Mycoglaena myricae*; *Capronia peltigerae*, *Lichenoconium erodens, Muellerella hospitans*, *M. ventosicola*, *Phaeopyxis punctum*, *Phoma cladoniicola, Plectocarpon cladoniae*, *Polycoccum minutulum*, *Tremella candelariellae*. An additional 35 lichens, two related fungi, and 13 lichenicolous fungi are new for Ontario: *Acarospora macrospora, Biatora chrysantha, B. turgidula, Biatorella hemisphaerica, Botryolepraria lesdainii*, *Buellia griseovirens, Caloplaca saxicola, C. subsoluta, Cladonia atlantica, Clauzadea monticola, Cliostomum leprosum, Diplotomma venustum, Enterographa zonata, Farnoldia hypocrita, Gyalecta foveolaris, Hymenelia heteromorpha, Lempholemma isidiodes*, *Lepraria caesiella, L. eburnea, Leptogium intermedium, Opegrapha rufescens, Placidium squamulosum, Porpidia contraponenda, P. macrocarpa* f. *nigrocruenta, P. soredizodes, P. superba, Pseudosagedia aenea, Psorotichia schaereri, Pycnora sorophora, Sagiolechia protuberans, Thelocarpon epibolum* var. *epithallinum, Trapeliopsis pseudogranulosa, Vezdaea acicularis, Violella fucata* and *Xylographa vitiligo; Epigloea pleiospora* and *Sarea difformis; Clypeococcum hypocenomycis, Cornutispora ciliaris, Lettauia cladoniicola*, *Lichenodiplis lecanorae, Marchandiomyces corallinus*, *Muellerella erratica*, *M. lichenicola, Nectriopsis parmeliae, Phoma cladoniicola, Pronectria robergei, Refractohilum peltigerae* and *Spirographa fusisporella*. A total of 77 range extensions are presented, many of which are significant discoveries, but others of which represent the first Canadian records of species that have been found to be common and widespread in adjacent regions of the United States. With regard to lichens, the parks now constitute the best-studied area of their size in Ontario. *Eiglera flavida* is an additional report for Bruce County not collected on the workshop; it is also new for Ontario. Of the habitats visited in the park, the shoreline cliffs and adjoining forests at Halfway Log Dump are the most rich in species (223). Flowerpot Island was almost as diverse (196). Although somewhat less diverse, the alvars (with 149 species) also contained several remarkable records and a surprising number of species.

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[1] IRWIN M. BRODO – Canadian Museum of Nature, P.O. Box 3443, Station 'D,' Ottawa, Ontario, K1P 6P4, Canada. – e-mail: ibrodo@mus-nature.ca

[2] RICHARD C. HARRIS – Institute of Systematic Botany, New York Botanical Garden, Bronx, NY 10458-5126, U.S.A. – e-mail: rharris@nybg.org

[3] WILLIAM BUCK – Institute of Systematic Botany, New York Botanical Garden, Bronx, NY 10458-5126, U.S.A. – e-mail: bbuck@nybg.org

[4] JAMES C. LENDEMER – Institute of Systematic Botany, New York Botanical Garden, Bronx, NY 10458-5126, U.S.A. – e-mail: jlendemer@nybg.org

[5] CHRIS LEWIS – Ontario Ministry of Natural Resources Species at Risk Branch 300 Water St., 2nd Floor South Peterborough, Ontario K9J 8M5, Canada. – e-mail: Chris.Lewis@ontario.ca

INTRODUCTION

The Bruce Peninsula in southern Ontario, Canada, is approximately 100 km long and 38 km wide at the base. It extends northwestward into Lake Huron, segregating off Georgian Bay (Fig. 1). Together with Manatoulin Island to the west, it forms the northern edge of the Niagra Escarpment, a formation of Silurian and Ordovician sedimentary, carbonate rock that arches through southern Ontario and from Rochester, New York at one end to the west coast of Lake Michigan at the other (Lowes 1988; Wikipedia 2013). The Bruce Peninsula falls entirely within the "Humid High-Cool Temperate" ecoclimatic province (Ecoregions Working Group 1989). Its forest cover is a mixture of eastern white cedar (*Thuja occidentalis*) over the thin, often wet, mainly calcium-rich soils, and mature, maple-dominated hardwood forest on deeper soils.

After a brief visit to the Bruce Peninsula, in August of 2007 by the senior author, it was decided that the area would make an ideal venue for a Tuckerman Workshop. Tuckerman Workshops are organized by the Eastern Lichen Network (2013), generally once a year over four days, to study the lichens of some area of eastern North America. The first one was held in 1994 in the Catskill Mountains of New York and organized by Dr. Richard Harris of the New York Botanical Garden. Participants of the workshops are amateur and professional lichen experts, most with some field and lab experience. Prior to the workshop on the Bruce Peninsula there had been three previous workshops in Canada, two in Nova Scotia and one in Newfoundland. Two more have been held since, one in New Brunswick and the other on the Gaspé Peninsula of Québec.

Previous compilations resulting from Tuckerman Workshops have either been authored by a single individual or have included all the participants. In this case the authors consist of the organizers of the trip (IMB and CL) as well as three of the participants who amassed most of the records and performed the great majority of identifications (WB, RH and JL).

THE LICHENS OF ONTARIO: A BRIEF HISTORY.

Previous work. The lichens of Canada are relatively poorly known. We estimate that there are about 3000 species in the country, but a catalogue or even a checklist has never been compiled. (One is now underway under the sponsorship of the Committee on the Status of Endangered Wildlife in Canada [COSEWIC].) Our poor knowledge is due in large part to the size and diversity of the country, as well as the few individuals who have concentrated on these organisms, even though lichens form an important and conspicuous part of the vegetation of the north (Kershaw 1977). Indeed, the farther north one goes, the greater the significance of the lichen flora as regards coverage and biomass (Kershaw 1978).

The province of Ontario, extending from the temperate Carolinian forest in the southeast to the arctic Hudson Bay coast at Polar Bear Provincial Park, should have a rich and diverse representation of species. At the time of the Tuckerman Workshop, 822 species had been documented for the province as compared with about 960 for Québec and ca. 2000 for British Columbia (C. Lewis, C. Roy and T. Goward, respectively, personal communications). A survey of the lichens of Bruce Peninsula National Park and Fathom Five National Marine Park was particularly desirable because the parks are rich in calcium-containing rocks (limestone and dolomite), which provide substrate for a distinctive and inadequately studied segment of the lichen flora of the province (Eykes 2002).

A review of early work on the lichens of Ontario is given in Wong & Brodo (1992) and Goward et al. (1998). A short history of lichenology in Ontario from the latter publication is reproduced below. (Additional comments are inserted in square brackets.)

> Among the first to collect Ontario lichens was the great American naturalist, Louis Agassiz. Agassiz sampled the rich lichen flora along the north shore of Lake Superior, and sent his collections to Tuckerman for identification (Tuckerman 1850). B. Billings and A.T. Drummond, both of Kingston, probably collected together, but only Billings published specifically on Ontario lichens (Billings 1862). Billings also identified the Great Lakes collections of Robert Bell (Bell 1861). [John Macoun, the Dominion botanist in Ottawa from 1881 until 1912, also collected many lichens from the Ottawa and Belleville areas as well as elsewhere in Ontario. His lichens were also identified by Tuckerman and other lichenologists of the day.] Other than J.H. Faull's (1913) list of common lichens near Toronto, almost no additional literature appeared dealing with Ontario lichens until the 1960s. Between the 1930s and the early 1970s, however, Roy Cain, a mycologist of broad interests and talents at the University of Toronto, did a great deal of collecting throughout Ontario.

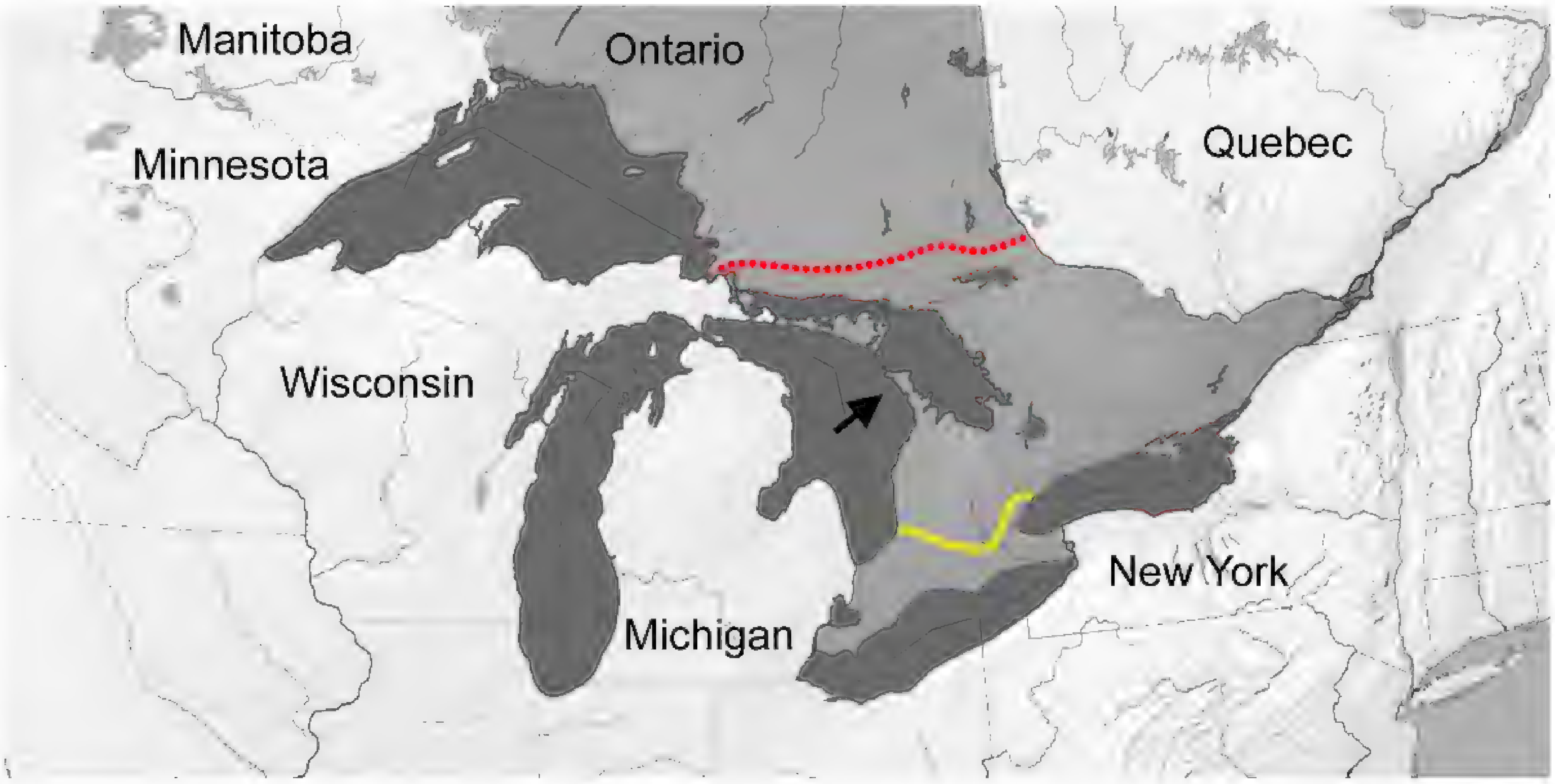

Figure 1, topographic map illustrating the relative position of the Bruce Peninsula (denoted by arrow) within Ontario (darkened land mass), the Great Lakes (darkened water bodies) and the surrounding area (lighter regions with major adjacent states and provinces as labeled). Superimposed on the map are lines indicating the boundary between 1) the Mid and Low Boreal Ecoclimatic Zone and Humid High-Cool Temperate Ecoclimatic Zone (red line) and 2) the Humid High-Cool Temperate and Humid High-Moderate Temperate Ecoclimatic Zone (yellow line). Ecoclimatic zones follow Newmaster et al. (1998) and are based on Ecoregions Working Group (1989).

> In 1964, Teuvo Ahti published his monumental study of the distribution of macrolichens in northern Ontario (Ahti 1964), which remains the most comprehensive lichen study yet conducted in the province. Noteworthy contributions to our knowledge of the ecology and ecophysiology of Ontario lichens have been made by Roland Beschel, Dianne Fahselt, Kenneth Kershaw, Douglas Larson and G.A. Yarranton. Major floristic contributions include those of Brodo (1981, 1988) and Wong & Brodo (1973, 1990, 1992) for the Ottawa region and southern Ontario respectively. Various studies on boreal portions of the province have also appeared, including those of Sjors (1961), Carleton (1982, 1990), Carleton & Maycock (1981), Brumelis & Carleton (1989), Kenkel (1986, 1987) and Nimis (1985). The lichens of the Thunder Bay District were summarized by Joan Crowe (1994; Ahti & Crowe 1995). Recently, a checklist of the lichens of Ontario was compiled from literature reports by Steven Newmaster, under the auspices of the Ontario Ministry of Natural Resources (Newmaster et al. 1998). [This initial list has been regularly updated by Chris Lewis and Troy McMullin, and a new edition has recently been prepared (Newmaster et al., in press).]

Recent work. In the last decade, significant discoveries of Ontario lichens have been made by Robert E. Lee, especially near White Lake, and by Chris Lewis and Troy McMullin throughout Ontario. Some areas where new collections and finds have been made include Algonquin Provincial Park (Lewis et al., in prep.), Sandbanks Provincial Park (McMullin and Lewis in prep.), and the Copeland Forest Resource Management Area (McMullin and Lendemer in press).

Bruce County was considered part of Southern Ontario in the catalogue by Wong and Brodo (1992), and 104 species were listed for the county, which extends from Tobermory in the north to close to Owen Sound in the south (Appendix A). Wong's field work in the county was done almost entirely outside the park boundaries (P.Y. Wong, personal communication). Little has been published on the lichens of the county since then, with the exception of Schaefer and Larson (1997), who reported (but did not list) 53 species in a study of the environmental conditions that create and maintain the Bruce alvar vegetation. Doug Larson and his students at Guelph University have also produced lists and reports of some lichens found on the cliffs within the National Park or Bruce Peninsula (e.g., a few localities in Haig 1997). Some interesting reports of alvar lichens were also made from the Federation of Ontario Naturalists' Bruce Alvar Nature Reserve: Catherine S. Wishart Tract (Varga et al. 1995).

SURVEYS OF CANADIAN NATIONAL PARKS: AN OVERVIEW.

There have been few lichen surveys done in Canada's national parks. The most outstanding work was done in the Maritime Provinces, first by I. Mackenzie Lamb on the lichens of Cape Breton Island, Nova Scotia (Lamb 1954; only partly within the present park boundaries); and by Sharon Gowan on Fundy National Park, New Brunswick (Gowan & Brodo 1988). Surveys have also been completed for Kouchbouguac National Park in New Brunswick (Gowan 1980) and Kejimkujik National Park in Nova Scotia (McMullin 2009, 2012). Collecting has been done by various individuals in western parks such as Jasper (John 1989, Hrapko & La Roi 1978); Gwaii Haanas National Park Reserve (Brodo & Sloan 2005); Wapusk National Park in Manitoba (Piercey-Normore 2005, 2006); Wood Buffalo National Park (Timony & Robinson 1992), and Kluane National Park (Hoefs & Thomson 1972, Douglas & Vitt 1976) with incidental work done in others, some of it not published, and not for the purpose of documenting the complete lichen flora. An in-depth study of the lichens of Grasslands National Park in Saskatchewan is now underway (C. Freebury, in prep.).

MATERIALS AND METHODS

Identifications. – Initial identification work was done in Tobermory at the workshop using standard techniques with microscopes borrowed from the University of Western Ontario and Canadian Museum of Nature (CMN), and some that were brought by the participants themselves. For most of the material, identifications had to be completed later and the lists submitted to the senior author. The lists were then compiled by Heather Coffey. Many questionable reports were double-checked by the authors. Specimens collected by participants were deposited in the following publicly accessible herbaria: Brodo, Coffey, Freebury, Lee, Lewis: Canadian Museum of Nature (National Herbarium of Canada), Ottawa [CANL]; Buck, Harris, Lendemer: New York Botanical Garden, Bronx, NY, USA [NY]; Wetmore: University of Minnesota, St. Paul, MN, USA [MIN]; Clayden: New Brunswick Provincial Museum, St. John, NB [NBM]; Bennett: University of Wisconsin, Madison, WI, USA [WIS]; McMullin: University of Guelph [OAC]; Ladd: [hb. Ladd]. Voucher specimens from other participants will eventually be deposited in one of the above herbaria or other institutions. Duplicates will be sent to Parks Canada in Tobermory for their own collection.

Localities visited (locality numbers used in annotated list). – A total of thirteen localities were visited as part of this study and a map of these is provided in Fig. 2.

1. Ontario. Bruce County: Bruce Peninsula National Park, Halfway Log Dump on Georgian Bay, 45°14'01"N, 81°28'41"W, ca. 180 m; *Thuja*-dominated forest over Silurian dolomite with numerous moss-covered boulders and escarpments.

2. Ontario. Bruce County: Bruce Peninsula National Park, just SW of parking area for Halfway Log Dump, 45°13'38"N, 81°28'50"W, ca. 190 m; *Acer saccharum*-dominated forest.

3. Ontario. Bruce County: Bruce Peninsula National Park, Shingle Marsh along road to Halfway Log Dump, 45°13'20"N, 81°28'16"W, ca. 180 m; wetlands with dead *Thuja* and *Myrica gale* shrub layer.

4. Ontario. Bruce County: Bruce Peninsula National Park, along SE shore of Bartley Lake, along road to Halfway Log Dump, ca. 1.2 km SW of jct of Emmett Lake Road, 45°12'50"N, 81°21'15"W, ca. 190 m; *Thuja*-dominated forest on lake shore.

5. Ontario. Bruce County: Bruce Peninsula National Park, Singing Sands, 45°11'36"N, 81°35'03"W, ca. 180 m; old sand dunes with *Pinus banksiana*.

6. Ontario. Bruce County: Bruce Peninsula National Park, Singing Sands, The Dorcas Alvar, 45°11'24"N, 81°35'29"W, ca. 180 m; alvar on lake shore.

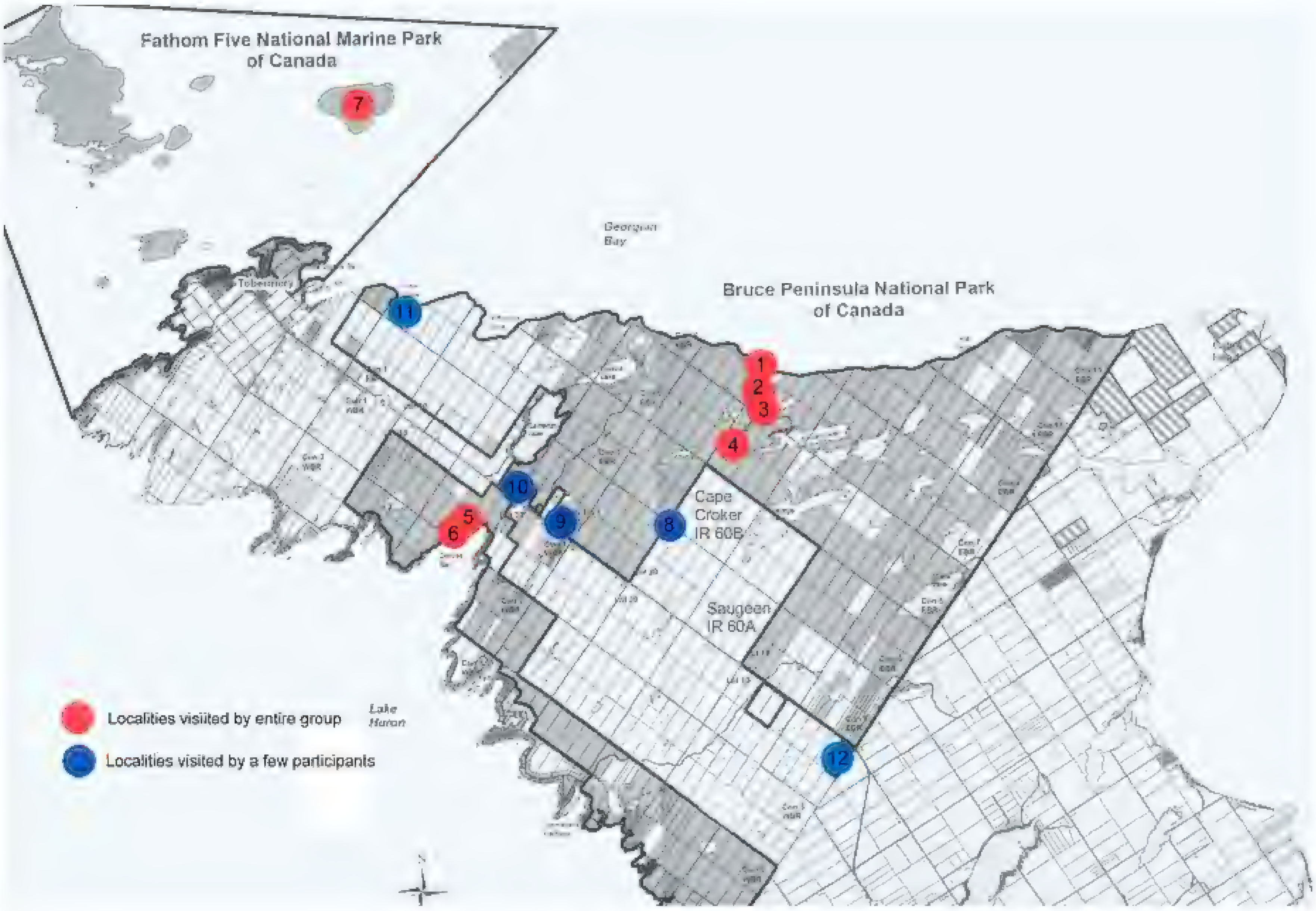
Fathom Five National Marine Park of Canada
7
Georgian Bay
Tobermory
Bruce Peninsula National Park of Canada
11
1
2
3
4
10
5
6
9
8
Cape Croker IR 60B
Saugeen IR 60A
12
● Localities visited by entire group
● Localities visited by a few participants
Lake Huron

Figure 2, Bruce Peninsula National Park and Fathom Five National Marine Park showing collection localities.

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7. Ontario. Bruce County: Fathom Five National Marine Park, Flowerpot Island, along SE portion of Flowerpot Loop Trail, and along the Marl Trail, 45°18’14″N, 81°36’43″W, ca. 180 m; *Thuja*-dominated forest over Silurian dolomite, with extensive outcrops and boulder fields.

8. Ontario. Bruce County: Bruce Peninsula National Park, Roadside Alvar NW of Emmett Lake Road, 2.7 km NE of Hwy 6, 45°11’52″N, 81°30’23″W, ca. 190 m.

9. Ontario. Bruce County: Bruce Peninsula National Park, Forest Building, off Route 6, 45°11’03″N, 81°32’24″W; old *Thuja* stand.

10. Ontario. Bruce County: Bruce Peninsula National Park, Acorn Lake, 45°12’06″N, 81°33’54″W; mature maple-oak forest.

11. Ontario. Bruce County: Bruce Peninsula National Park, Little Cove shoreline, 45°14’55″N, 81°36’44″W, ca. 180 m; *Thuja*-dominated forest over Silurian dolomite with numerous moss-covered boulders and escarpments.

12. Ontario. Bruce County: Bruce Peninsula, S of Tobermory, 45°08’N, 81°27’W; extensive alvar, *Thuja occidentalis* stand. [Federation of Ontario Naturalists’ Bruce Alvar Nature Reserve.]

13. Ontario. Bruce County: Bruce Peninsula National Park, near Tobermory, NE of Highway 6, opposite Dorcas Bay Road, 45°12’05″N, 81°33’09″W, 200 m; *Thuja* swamp. [Not mapped in Fig. 2; very close to Locality 9.]

Locality	Lichens	Fungi	Parasites	Total species
1 (Halfway Log Dump shoreline and cliff)	179	7	8	**194**
2 (Halfway Log Dump, maple forest)	124	4	7	**135**
3 (Shingle Marsh near Halfway Log Dump)	72	4	5	**81**
4 (Bartley Lake)	48	1	1	**50**
5 (Sand dunes at Singing Sands)	51	0	5	**56**
6 (Dorcas Alvar, Singing Sands)	109	2	6	**117**
7 (Flowerpot Island)	184	4	8	**196**
8 (Alvar at Emmett Lake Road)	66	2	1	**69**

Table 1, numbers of species at eight main Workshop stops (1-8) listed by locality.

RESULTS

LICHEN DIVERSITY

A total of 370 species were found, including 330 lichens, 26 lichenicolous fungi and 14 fungi related to lichens. An annotated list is given in Appendix C. An additional 21 species of lichens reported from Bruce County before the present survey were not found in the parks during the Tuckerman Workshop, including four found only at the Bruce Alvar Nature Reserve (Nature Ontario tract); these are listed separately at the end of the annotated list. The coastal rocks and cliffs and the adjoining forest near Halfway Log Dump (Localities 1 and 2) yielded the greatest diversity (223 species) and most rarities, with Flowerpot Island being the next richest area studied with 196 species (Table 1).

SYNOPSIS OF LICHEN COMMUNITIES BY HABITAT

Lakeshore beaches, bluffs and humid woods. (Halfway Log Dump, Flowerpot Island):

On beach rocks. Along the beach, there are cobbles at the water's edge grading into large exposed boulders, as well as shaded, mossy boulders and cliff faces at the upper edge of the beach some of which descend directly to the water. Each of these has a somewhat different lichen community. On the exposed boulders, there are foliose to semifoliose lichens such as *Collema undulatum, Dematocarpon* species, *Xanthoria elegans,* and *X. sorediata*. Crustose lichens are common on the rock surface, especially *Caloplaca cirrochroa, C. flavocitrina, Lecanora semipallida, Placynthium nigrum, Protoblastenia rupestris, Staurothele drummondii* and *Verrucaria calkinsiana.* The rarely reported *Acarospora moenium*, usually found on mortar or concrete, was also found on these rocks. On more shaded rocks: *Botryolepraria lesdainii, Solorina saccata*; and a number of lichens with *Trentepohlia* as their photobiont: *Gyalecta jenensis, G. foveolaris, Hymenelia epulotica* (also on sunny rocks), as well as the rare *Opegrapha dolomitica* and the arctic lichens, *Eiglera flavida* (not refound at the Workshop), *Hymenelia heteromorpha* and *Sagiolechia protuberans*. Free-living *Trentepohlia* is also common on shaded rocks in this habitat. Because it is generally orange due to carotinoid pigments in its cells, this alga is often mistaken for an orange lichen. The rare *Lempholemma isidioides* and *Psorotichia schaereri,* both with cyanobacteria as a photobiont, were also on shaded rocks.

On the trees at the bottom of the escarpment and just behind the top of the bluff (mostly *Thuja occidentalis*) the foliose lichen flora consists of *Hypogymnia physodes, Melanelixia fuliginosa, M. subaurifera, Parmelia sulcata, Physcia adscendens, Ph. aipolia* and *Punctelia rudecta.* In a few spots, the large and spectacular lungwort, *Lobaria pulmonaria*, occurs. Abundant crustose lichens include *Lecanora rugosella, L. pulicaris, Micarea peliocarpa, Mycobilimbia carneoalbida*, and *M. hypnorum* as well as some sterile leprose lichens: *Lepraria caesiella* and *L. finkii.* The rarely collected *Biatora chrysantha* was also found on the bases of cedars.

On driftwood, the rare *Pycnora sorophora* and mostly western *Xylographa vitiligo* were collected. Rarities on moss include *Bacidia bagliettoana* and *Lempholemma polyanthes.*

Maple forest (Halfway Log Dump, Acorn Lake campsite, edge of Bartley Lake):

On hardwood trees. The forest habitat is relatively shaded due to the dense maple canopy and so most lichen species are those that tolerate some shade. Most common are *Phaeophyscia pusilloides, Ph.*

rubropulchra, Physconia detersa, Punctelia rudecta and *Pyxine sorediata* among the foliose species; and, among the crustose species, *Graphis scripta, Lecanora hybocarpa, L. rugosella, L. thysanophora, Pertusaria macounii, Phlyctis argena, Scoliciosporum chlorococcum* and *Variolaria amara,* as well as the less common *Bacidia rubella, Coenogonium pineti* and *Scoliciosporum umbrinum*, a lichen usually collected on rock. *Catinaria atropurpurea* was found there on lignum. The pyrenomycete lichens, *Anisomeridium polypori* and *Acrocordia cavata,* are also found in the maple forest. Representing the tiny stubble lichens are *Mycocalicium subtile, Chaenotheca ferruginea, C. furfuracea* and *C. trichialis,* as well as *C. brachypoda*, which is very rare.

On the ground and stones. *Myxobilimbia sabuletorum* is found on mossy rocks or tree bases together with the cyanobacteria-containing pelt lichens *Peltigera elisabethiae, P. evansiana, P. praetextata* and *P. rufescens.* Seventeen species of *Cladonia* are on tree bases, logs, rocks or soil, especially *C. chlorophaea, C. ochrochlora* and *C. scabriuscula.* Among the rarities, *Biatorella hemispherica* was found on moss, *Thelidium decipiens* was on dolomite and *Vezdaea acicularis* was on soil.

Exposed Thuja *at the edge of a swamp*. (Shingle Swamp):

All these species are characteristic of sunny, exposed tree bark or weathered wood, with the possible exception of *Cresponia chloroconia,* which also grows in shade. The fruticose lichens include *Evernia mesomorpha, Ramalina intermedia* and *Usnea hirta,* all forming yellowish green tufts on the branches and trunks. The foliose lichens are *Flavoparmelia caperata, Hypogymnia physodes* and *Imshaugia aleurites.* The crusts, some found only (or only abundant) in this habitat, include *Amandinea punctata, Buellia griseovirens, Candelariella efflorescens, Catillaria nigroclavata, Lecanora albella, L. caesiorubella, L. meridionalis, Varicellaria velata* and *Variolaria amara.* The parasitic *Sphinctrina anglica* was growing on *Protoparmelia hypotremella.* A remarkable find in Shingle Swamp (and also on Flowerpot Island) was *Evernia prunastri*; these are the first southern Ontario records of this mainly western fruticose species since 1874.

Pine stand over sand dunes (Singing Sands):

On the ground. The pine grove over sand has a special lichen flora since it is among the few habitats with acidic soil conditions in the study area. Even so, one or two calciphiles, such as *Cladonia pocillum,* make an appearance. On the sand itself are many species of *Cladonia* including *C. cristatella, C. mitis s. str.*, *C. phyllophora, C. rangiferina* and *C. turgida*; also *Cetraria arenaria* and *Peltigera rufescens.* Many lichen parasites are in this habitat, some of them rare, such as *Lettauia cladoniicola, Leucogyrophana lichenicola* and *Lichenosticta alcicorniaria*.

On the trees. The arboreal lichens, all on conifers such *Pinus banksiana* and *Picea glauca* include the fruticose lichens *Bryoria furcellata, Evernia mesomorpha* and *Usnea hirta;* the foliose lichens *Imshaugia aleurites, I. placorodia, Parmeliopsis capitata, P. ambigua, Tuckermanopsis americana, T. sepincola;* and the crustose species *Buellia schaereri, Chrysothrix caesia, Lecanora pulicaris, L. symmicta* and *Scoliciosporum chlorococcum.* A number of calicioid lichens were on the conifers: *Chaenotheca ferruginea, C. furfuracea, Mycocalicium subtile*, and the parasitic *Sphinctrina anglica* growing on the inconspicuous *Protoparmelia hypotremella* (also seen in Shingle Swamp).

Alvar lichens (Dorcas alvar, Emmett Lake alvar.):

On rock pavement (calcareous dolomite). The most common species on the exposed rocks are *Acarospora glaucocarpa* (in its many forms), *Bagliettoa baldensis, Collema undulatum* var. *granulosum, Dermatocarpon dolomiticum, Hymenelia epulotica, Lecidella stigmatea* and *Protoblastenia rupestris.* Also in this community are a few species of *Verrucaria,* such as *V. nigrescens,* and the rarer *Acarospora macrocarpa, Caloplaca subsoluta* (near the lake shore) and *Dermatocarpon muhlenbergii.* At the Emmett Lake alvar, other rare lime-loving species were collected: *Acarospora veronensis* (which can also grow on other substrates including wood), *Clauzadea monticola* and *Collema coccophorum.*

Granitic (non-calcareous) erratic boulders lying on the alvar pavement have their own community, typical of the Canadian Shield: *Acarospora fuscata, Lecanora polytropa, Rhizocarpon grande, R. obscuratum, Stereocaulon saxatile Xanthoparmelia cumberlandia* and *X. plittii.* A remarkable find on one boulder was *Lecidea atrobrunnea,* an arctic-alpine species that is occasionally found further south in montane communities.

On soil. Both *Placidium squamulosum* and *Clavascidium lacinulatum* are found on alvar soil, together with *Psora decipiens* (a mainly northern and central to western species), the coastal plain disjunct

Cladonia atlantica, C. magyarica, C. mitis, C. multiformis, C. pocillum, C. rangiferina, C. stellaris, Peltigera rufescens and *Toninia sedifolia.* The rare and very inconspicuous *Vezdaea acicularis* was growing on soil covering the root mass of an up-turned tree.

On mosses. *Caloplaca sinapisperma* and *Mycobilimbia hypnorum* and, at the Emmett lake alvar, the rare cyanolichen *Heppia adglutinata.*

On trees and wood. Some lichens grow on snags and branches of scrubby trees on the alvar: *Hypocenomyce scalaris, Lecanora pulicaris, Parmeliopsis ambigua*; the rarer lichens on wood include *Biatora turgidula, Caloplaca amniospila, Pycnora sorophora* and *Violella fucata.*

Flowerpot Island specialties. (See also "Lakeshore beaches, bluffs and humid woods" above.)

Because Flowerpot Island is characterized by a high level of constant humidity, its lichen flora is especially rich and includes rarer species not found in the same sort of community described for coastal bluffs.

On the rocks there were 13 species of *Caloplaca* including *C. chlorina, C. crenulatella* and *C. saxicola*; also *Bacidia egenula, Catillaria lenticularis, Lecania cuprea, Lichinella nigritella*, *Polyblastia cupularis, Rinodina bischoffii, Sarcogyne regularis* and *Theldium minutulum. Trapelia placodioides* was on shaded non-calcareous rocks in the forest.

Trees in the forest had some species not seen, or infrequently seen, elsewhere: *Bacidia laurocerasi* and *Biatora pycnidiata* (on *Populus*); *Biatora ocelliformis* and *Pseudosagedia aenea* (on *Acer spicatum*); *Coenogonium pineti, Pyrenula pseudobufonia,* six species of *Chaenotheca, Diplotomma alboatrum, Ramalina obtusata, R. pollinaria,* four species of *Usnea* and *Usnocetraria oakesiana* (on various trees). *Trapeliopsis pseudogranulosa,* formerly known in North America only from the west, was found on spruce bark. Two fungi related to lichens were growing on dried, hard conifer resin: *Sarea resinae* and the very rare *S. difformis.*

Ground lichens in the forest included the basidiomycete lichen, *Multiclavula muscida,* as well as *Peltigera aphthosa* and *P. leucophlebia* (both containing green algae), and *P. horizontalis* and *P. polydactylon* (containing cyanobacteria).

ANNOTATED LIST OF LICHENS AND RELATED FUNGI FROM THE BRUCE PENINSULA NATIONAL PARKS

The list below is presented below is arranged alphabetically by genus and species. New records are indicated in the list as follows: **new for Canada;** new for Ontario. Non-lichenized fungi related to lichen-forming fungi are preceded by a dagger (†). Author abbreviations follow the North American checklist (Esslinger 2012). Collection numbers are given as provided to the authors by the collectors. A list of lichenicolous fungi follows this list.

Acarospora americana H. Magn. – *Buck 54234, 54247*. Locality 8. On rock in alvar. This species has recently been revised, discussed and illustrated by Knudsen et al. (2011), who reported Canadian specimens from Saskatchewan and Québec as well as those cited here. A review of CANL material revealed two additional specimens from southern Ontario, one from Ottawa (*Macoun 66*, 7.v.1897) and one from Leeds County (*Wong 2312)*.

Acarospora fuscata (Schrader) Arnold – *Harris 56521, Hinds 5336, Lay 08-0038, Lendemer 14441-A.* Localities 2, 6, 8, 12. On siliceous glacial erratics.

Acarospora glaucocarpa (Ach.) Körber – *Buck 54119, 54119, 54275, Bennett 02, 03, 04, Brodo 32321, 32340, 32341, Freebury 662, 690B, Harris 54925, 54997, 55019, Hinds 5332, 5354, 5367, 5368, Lay 08-0039, 08-0040, 08-0041, 08-0042, Lendemer 14363, 14475, 14153, 14128, 14307, 14298-A, 14360-A, Lewis 284, McMullin 2966, Wetmore 97609, 97747.* Localities 1, 2, 4, 6, 7, 8. On limestone.

Acarospora macrospora (Hepp) A. Massal. *ex* Bagl. – *Brodo 32348, Buck 54276, Hinds 5364.* Localities 6, 7. On limestone. This is a common species in Europe known from dry interior and coast of British Columbia (Noble et al. 1987).

***Acarospora moenium* (Vainio) Räsänen** [syn. *Aspicilia moenium* (Vainio) Thor & Timdal] – *Beeching 6677* (det. Lendemer). Locality 1. On open limestone boulder. This inconspicuous species was known from New England and Colorado (LaGreca and Lumbsch 2001; Weber 1990). Although listed as an *Aspicilia* in the recent North American checklist (Esslinger 2012), recent work has shown it to be an *Acarospora* (Nordin et al 2009).

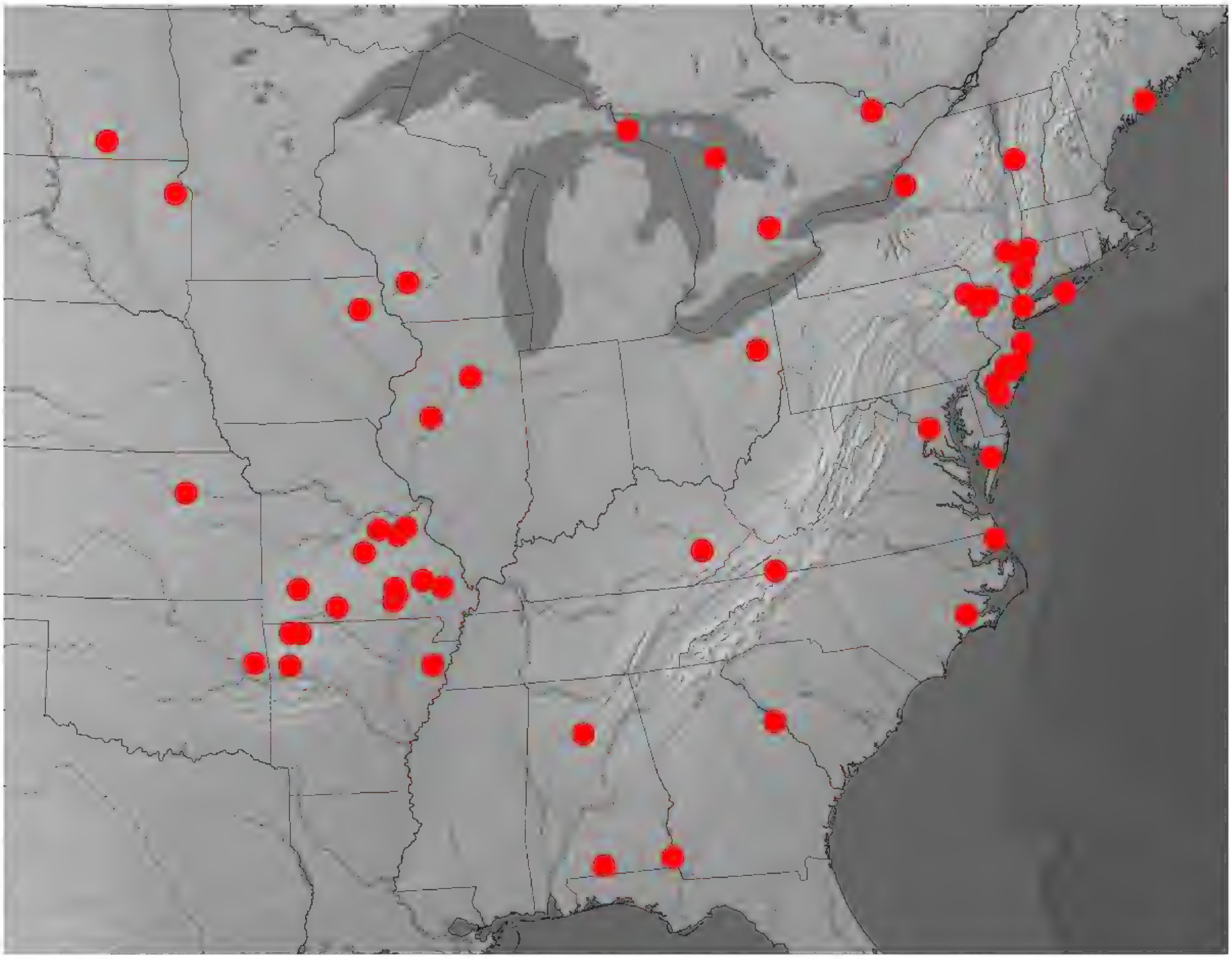

Figure 3, North American distribution of *Bacidina egenula* based on specimens in NY and CANL.

Acrocordia cavata (Ach.) R.C. Harris – *Brodo 32327, Harris 54881, Guccion 1252, 1284, Ladd 30187*. Localities 1, 2, 7. On *Populus tremuloides* and *Acer saccharum*.

Acrocordia conoidea (Fr.) Körber – *Buck 54107, 54302, Lewis 283*. Localities 1, 2, 7. On limestone.

Agonimia spp. – *Bennett 05, 06, Buck 54109, Lendemer 14188, 14168, Wetmore s.n.* Localities 1, 2. On moss over soil. The specimens cited above are identified only to genus because the species-level taxonomy of *Agonimia* in North America is in desperate need of revision and we do not feel that any of our collections can be assigned to a species with certainty.

Amandinea punctata (Hoffm.) Coppins & Scheid. – *Brodo 32254, Buck 54217, Hinds 5330, Ladd 30344, Lay 08-0044, Lendemer 14568, 14287, 14515, Wetmore 97624, 97677.* Localities 1, 2, 3, 5, 7. On bark and wood of various trees and shrubs.

Anaptychia crinalis (Schaerer) Vězda – *Bennett 08, 09, Buck 54142, Dibble 17082, Hinds 5311, Ladd 30348, 30386, Lay 08-0045, Lendemer 14119, 14535, Lewis 260, McMullin 2901, Olszewski 6729, Wetmore 97632, 97757.* Localities 1, 2, 7. On moss, calcareous soil and rock.

Anisomeridium polypori (Ellis & Everh.) M.E. Barr – *Brodo 32292, 32346, Buck 54108, Harris 54869, 54926, Ladd 30163, Lendemer 14210, 14264, 14325.* Localities 1, 2, 3, 4, 7. On bark, especially *Thuja* and sometimes *Acer* and *Populus.*

Arthonia didyma Körber – *Brodo 32326*. Locality 7. On *Populus tremuloides* in forest.

Arthonia fuliginosa (Schaerer) Flotow – *Buck 54206*. Locality 3. On *Thuja*,

Arthonia patellulata Nyl. – *Bennett 10, Buck 54120, Guccion 1253, Harris 54858*. Localities 1, 2, 7. On bark of *Populus* or, rarely, *Acer*.

Arthonia radiata (Pers.) Ach. – *Brodo 32251, Lewis 293, Wetmore 97641*. Localities 2, 10. On bark of *Quercus* and *Acer.*

Arthrosporum populorum A. Massal. – *Harris 56580.* Locality 7. On upper branches of fallen, dead *Populus.*

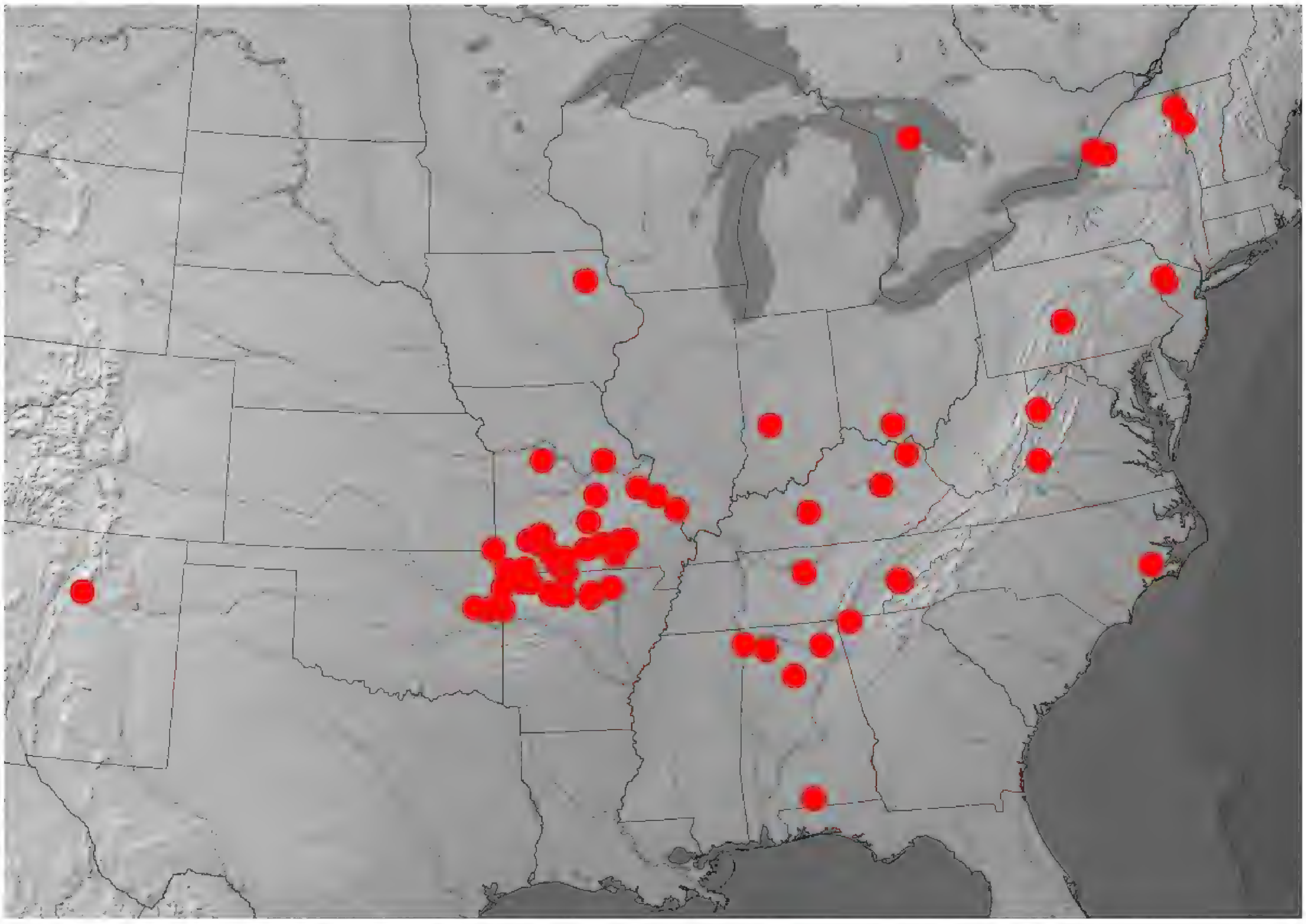

Figure 4, North American distribution of *Bagliettoa baldensis* based on specimens in NY and CANL.

Aspicilia cinerea (L.) Körber – *Bennett 11, Lendemer 14397, Lewis 294*. Localities 2, 6, 8. On granite [erratic] boulders.

Alyxoria varia (Pers.) Ertz & Tehler [syn. *Opegrapha varia* Pers.] – *Ladd 30331, Lendemer 14166, 14145, Lewis 248*. Localities 1, 7. On *Thuja*. Following Ertz and Tehler (2011) we here treat *O. varia* in the genus *Alyxoria*.

Bacidia bagliettoana (A. Massal. & De Not.) Jatta – *Brodo 32264A, Harris 56472, Wetmore 97754*. Localities 1, 6, 8. On bryophytes at edge of beach.

Bacidia coprodes (Körber) Lettau – *Buck 54127*, *Lendemer 14556*. Locality 1, 7. On dolomite.

Bacidia laurocerasi (Delise *ex* Duby) Zahlbr. subsp. *laurocerasi* – *Brodo 32351*, *Lay 08-0260*. Locality 7. On *Populus tremuloides* in forest.

Bacidia microcarpa (Th. Fr.) Lettau [syn. *Bilimbia microcarpa* (Th. Fr.) Hafellner] – *Buck 54321*. Locality 7. On humus.

Bacidia rubella (Hoffm.) A. Massal. – *Lendemer 14272, 14288, Freebury 664, Lewis 291, Harris 54918*. Localities 1, 2. On bark of *Acer saccharum*.

Bacidia schweinitzii (Fr. *ex* Tuck.) A. Schneider – *Guccion 1321, Hinds 5328, Lay 08-0258, Lendemer 14323*. Localities 2, 3, 7. On bark of *Acer* and *Thuja*.

Bacidina egenula (Nyl.) Vězda – *Lay 08-0276, Lewis 240*. Localities 2, 7. On limestone at the highwater line in shade. This lichen can grow on siliceous rocks and rarely bark (Ekman 1996), but its normal substrate is calcareous rock. Although Ekman (1996) documented its occurrence in North America only from eastern Ontario (on the base of *Ulmus americana*) and Louisiana, it had also been recorded from British Columbia (Noble et al. 1987) and has proven to be widespread on limestone in the east (Distribution map: Fig. 3, based on material at CANL and NY).

***Bagliettoa baldensis* (A. Massal.) Vězda** [syn. *Verrucaria baldensis* A. Massal.] – *Dibble 17193, Lendemer 14405*, *Lewis 278*. Locality 6. On exposed limestone. This small *Verrucaria*-like lichen is known from numerous localities in the east, especially the Ozark region (Harris and Ladd 2005) (Fig. 4) as well as Europe and Israel.

Bagliettoa calciseda (DC.) Gueidan & Cl. Roux – *Brodo 32307, Buck 54245, Wetmore 97633, 97779*. Localities 1, 6, 7, 8. On limestone boulders.

Biatora chrysantha (Zahlbr.) Printzen – *Harris 54895, 54916, Ladd 30183, Lendemer 14186, 14202, 14536*. Localities 1, 2, 7. On base of *Populus* and *Thuja*. Apparently this is the first published record for Ontario, although there is an unpublished record in CNALH (2011) from the Slate Islands (*Wetmore 28350*, MIN [n.v.]). The species is also known from New Brunswick (Fundy National Park), Nova Scotia, Vermont, coastal Maine and South Carolina (specimens in CANL and NY).

Biatora efflorescens (Hedl.) Räsänen – *Buck 54317*. Locality 7. On base of *Populus*.

***Biatora ocelliformis* (Nyl.) Arnold** – *Clayden 19443* p.p. Locality 7. On *Acer spicatum*. New for Canada, although there is a specimen from Haida Gwaii, British Columbia, tentatively identified as this species by Stefan Ekman in CANL. There are, however, specimens of the very similar *B. hypophaea* Printzen & Tønsberg from Washington and coastal Alaska (Prinzen and Tønsberg 1999), so that the British Columbian specimen may well be that taxon. *Biatora ocelliformis* was also reported by Printzen and Otte (2005) from Minnesota.

Biatora pycnidiata Prinzen & Tønsberg – *Clayden 19487*. Locality 7. On *Populus tremuloides*.

Biatora turgidula (Fr.) Nyl. [syn. *Lecidea turgidula* Fr.] – *Lendemer 14370*. Locality 8. On dead *Pinus*. This is apparently the first published record of *Biatora turgidula* for Ontario, although it appears to be widespread. There is an unpublished record (CNALH 2011) based on material collected near Cochrane and Hearst (*Wetmore 44012*, *44059*, both MIN[n.v.]). There are records from New Brunswick, Newfoundland and Labrador, and Québec (Fournier 2006), and CANL has specimens from Manitoba (Churchill) and the Yukon, as well as material from Minnesota, Arizona, South Dakota and Texas in the United States. NY has several specimens from New England and Missouri.

Biatora vernalis (L.) Fr. – *Buck 54219, Dibble 17085*. Localities 1, 3.

Biatorella hemisphaerica Anzi – *Buck 54135*. Locality 1. On humus. There are specimens in CANL from Alberta and British Columbia and one from New Jersey in NY. Additionally there are records we have not verified from Iowa in MIN and several from northern Illinois in F (CNALH 2011).

Bilimbia sabuletorum (Schreber) Arnold (syn: *Myxobilimbia sabuletorum* (Schreber) Hafellner) – *Bennett 13*, *Buck 54105*, *54112*, *54146*, *54148*, *Dibble 17129*, *Harris 54935*, *55031*, *Lay 08-0268*, *08-0269*, *08-0270*, *08-0271*, *Lendemer 14409*, *14280*, *14270*, *14310-A*, *14350*, *Olszewski 6779*. Localities 1, 2, 3, 4, 6, 7. On bryophytes over rock.

Botryolepraria lesdainii (Hue) Canals, Hernández-Mariné, Gómez-Bolea & Llimona – *Harris 54909, 55021, Lendemer 14133, 14206, 14209, 14560*. Localities 1, 7. On dolomite. Hopkins and Tønsberg (2006) summarized the distribution of this species in North America, reporting it from Alaska, New York, Pennsylvania, the southern Appalachians as well as British Columbia. Lendemer (2008) pointed out that it is actually common in the east, even occurring in city parks on the mortar of old stone walls, and presented a distribution map. The genus differs from *Lepraria* by having a byssoid (cottony) texture with grape-like bunches of algae at the hyphal tips and by the production of only terpenoids.

Bryoria furcellata (Fr.) Brodo & D. Hawksw. – *Harris 54977, Ladd 30337, Lay 08-0047, Lewis 230, Wetmore 97723*. Localities 1, 5, 6. On conifers.

Buellia disciformis (Fr.) Mudd [syn. *Hafellia disciformis* (Fr.) Marbach & H. Mayrhofer] – *Brodo 32339, Burke s.n., McMullin 2877*. Localities 1, 3, 7. On *Sorbus* and *Acer saccharum*.

Buellia erubescens Arnold [syn. *Buellia stillingiana* J. Steiner] – *Brodo 32329, 32343, Guccion 1286, 1322, 1323, Ladd 30237, Lay 08-0048, 08-0261, 08-0262, Lendemer 14308-B, 14500, Wetmore 97642, 97810*. Localities 1, 2, 6, 7. On bark of hardwoods. This synonymy should be verified using molecular techniques, especially because the epithet "*erubescens*" has been used in different senses in the literature and *B. stillingiana* has long been applied to a widespread and well understood lichen in North America (e.g., Brodo et al. 2001).

Buellia griseovirens (Turner & Borrer *ex* Sm.) Almb. – *Bennett 15, Brodo 32285, 32298, Lendemer 14431, 14430, 14587, 14183, 14132-A, 14322-A, Lewis 274. Localit*ies 1, 3, 5, 6, 7. On trunks and branches of conifers. This species is known from British Columbia and the western United States, although there are records from Nova Scotia and Québec (CANL) as well as Vermont and New York (NY). Another specimen was recently found in eastern Ontario (near Fitzroy Harbour, *Brodo*

33178, CANL), so it probably has been overlooked in the east and is much more common in the boreal forests than previously thought.

Buellia schaereri De Not. – *Guccion 1302, Lee 2405, Lendemer 14484.* Localities 1, 5, 7. On conifer bark and cones.

Calicium salicinum Pers. – *Buck 54209, Lendemer 14314-A*. Locality 3. On dead *Pinus.*

Calicium trabinellum (Ach.) Ach. – *Lendemer 14366, McMullin 2953,*. Localities 5, 8. On lignum.

Caloplaca ammiospila (Wahlenb.) H. Olivier – *Buck 54244, Harris 54888*. Localities 1, 8. On dead roots in wet open area, and branches of *Thuja.*

Caloplaca cerina (Ehrh. *ex* Hedwig) Th. Fr. – *Guccion 1254, Harris 54873, 54885, Hinds 5317, Lay 08-0049, 08-0284, Lendemer 14289-C, 14503-A, McMullin 2878, Wetmore 97639, 97664.* Localities 1, 2, 3, 7. On *Populus.*

Caloplaca chlorina (Flotow) H. Olivier – *Harris 55004, 55007, Lendemer 14131.* Localities 1, 7. On dolomite.

Caloplaca chrysodeta (Räsänen) Dombr. – *Buck 54128, 54128, Harris 54857, Lendemer 14161, 14159, 14133-A, 14561, Lewis 270.* Localities 1, 2, 7. Shaded limestone overhangs in forest.

Caloplaca cirrochroa (Ach.) Th. Fr. – *Hinds 5308, 5358, 5359, Ladd 30232, Lay 08-0050, Lendemer 14572, 14125-A, Lewis 258, Wetmore 97598, 97776.* Localities 1, 7. On limestone.

Caloplaca citrina (Hoffm.) Th. Fr. – *Buck 54323, Lendemer 14507, Wetmore 97627, 97770.* Localities 1, 7. On limestone.

Caloplaca crenulatella (Nyl.) H. Olivier – *Wetmore 97771.* Locality 7. On limestone boulders. In CANL, there are specimens from Thunder Bay in Ontario as well as Saskatchewan.

Caloplaca feracissima H. Magn. – *Guccion 1333, Hinds 5307, Lay 08-0278.* Localities 1, 3, 7. On limestone.

***Caloplaca flavocitrina* (Nyl.) H. Olivier** – *Hinds 5306, Ladd 30229A, Lendemer 14124, 14145.* Locality 1. In open, on limestone. This is the first published record for Canada, but it is included in an unpublished list of Nova Scotia lichens (Anderson, personal communication). It is much like *C. citrina,* and is sometimes listed as a synonym (e.g., Wetmore 2001), but has an areolate, often thicker, thallus becoming sorediate at the margins of the areoles. Many if not most records of *C. citrina* from eastern North America probably represent *C. flavocitrina*, but a detailed study including molecular data is needed to better circumscribe the species.

Caloplaca flavovirescens (Wulfen) Dalla Torre & Sarnth – *Brodo 32331, Buck 54313, Burke s.n., Guccion 1334, Harris 55008, Hinds 5367, Lay 08-0051, Lewis 282A, Lendemer 14539, 14144, 14522, McMullin 2968, Wetmore 97582, 96655.* Localities 1, 7. On limestone.

Caloplaca holocarpa (Hoffm. *ex* Ach.) A.E. Wade – *Bennett 16, Guccion 1255, Harris 54898, Ladd 30340, Lay 08-0052, Lendemer 14116, Lewis 285, McMullin 2879.* Localities 1, 7. On tree bark and limestone. The name *C. holocarpa* is used here in a broad sense that likely includes recently segregated taxa such as *C. pyracea* (Ach.) Zwackh (Arup 2009).

Caloplaca saxicola (Hoffm.) Nordin – *Ladd 30364, Lay 08-0054, 08-0053, Lendemer 14150, 14541.* Localities 1, 7. First record for Ontario. On calcareous rocks near shore. *Caloplaca saxicola* is a lobed, non-sorediate species usually producing abundant apothecia. There are specimens in CANL from Alberta, Saskatchewan, Québec (the Gaspé Peninsula) and Nunavut as well as from the central and western United States. It is quite common in the southwest (Wetmore 2007).

Caloplaca sideritis (Tuck.) Zahlbr. – *Beeching 6786* (det. Wetmore). Locality 7. On limestone cliffs.

Caloplaca sinapisperma (Lam. & DC.) Maheu & A. Gillet – *Brodo 32318, Buck 54239, 54265, Harris 54953, Lay 08-0055, Lendemer 14437, 14382, Wetmore 97731, 97733.* Localities 6, 8. On moss over alvar rock.

Caloplaca subsoluta (Nyl.) Zahlbr. – *Freebury 686, Hinds 5306, 5318, 5353, Ladd 30322, Wetmore 97616.* Localities 1, 6, 7. In open, on limestone. This lichen, with a bright orange, areolate to subsquamulose thallus, is widespread in the United States, but in Canada was recorded only from British Columbia (Wetmore 2003).

Candelaria concolor (Dickson) Stein – *Guccion 1324, Harris 55023, Hinds 5328, 5330, Lendemer 14131-A, 14305, McMullin 2880, Wetmore 97653.* Localties 1, 2, 7. On *Ulmus, Acer* and *Populus.*

Candelariella aurella (Hoffm.) Zahlbr. – *Bennett 17, Brodo 32356, Harris 55004-A, Hinds 5368, Lay 08-0056, 08-0256, Lendemer 14575, 14176, Lewis 281.* Localities 1, 7. Mostly on dolomite, but one on *Thuja* wood. The latter is not an unusual substrate for *C. aurella*, which is frequently collected on cedar fences.

Candelariella efflorescens R.C. Harris & Buck – *Freebury 667, 682, Harris 54941, Hinds 5330, Lendemer 14134, 14290, 14285, McMullin 2909, Olszewski 6728, 6786, Wetmore 97682.* Localities 1, 2, 3, 4, 6. On bark of *Thuja* and *Ulmus.*

Candelariella vitellina (Hoffm.) Müll. Arg. – *Brodo 32256, Buck 54222, 54238, 54305, Harris 54965, Hinds 5336, Ladd 30283, Lay 08-0057, 08-0058*. Localities 3, 5, 7, 8. Growing on siliceous erratic boulders as well as lignum, especially *Thuja*.

Candelariella xanthostigma (Ach.) Lettau – *Bennett 18, Ladd 30261, Wetmore 97583*. Localities 1, 2. On *Thuja* and lignum.

******Capronia peltigerae*** **(Fuckel) D. Hawksw**. – *Buck 54147*. Locality 1. On *Peltigera rufescens*.

Catapyrenium cinereum (Pers.) Körber – *Lewis 276*. Locality 6. In full sun on a shoreline alvar with scattered trees; on soil over limestone.

Catillaria lenticularis (Ach.) Th. Fr. – *Brodo 32260, Buck 54137, 54143, 54306, 54314, Harris 55003, Lay 08-0059, Lendemer 14584, 14538, 14216, Lewis 306, Wetmore 97617, 97635, 97768.* Localities 1, 2, 6, 7. On limestone.

Catillaria nigroclavata (Nyl.) Schuler – *Brodo 32288B, Lee 2406*. Localities 3, 7. On *Thuja*.

Catinaria atropurpurea (Schaerer) Vězda & Poelt – *Lay 08-0279*. Locality 2. On lignum.

Cetraria arenaria Kärnefelt – *Bennett 19, Brodo 32300, 32333, Burke s.n., Dibble 17182, Freebury 681, Guccion 1303, Harris 54983, 55032, Hinds 5342, 5343, 5362, Ladd 30304, Lay 08-0060, 08-0061, 08-0062, Lendemer 14445, McMullin 2950, 2954, 2969, Wetmore 97719.* Localities 5, 6, 7. On sandy soil.

Chaenotheca brachypoda (Ach.) Tibell – *Lee 2407*. Locality 1. Flake of partly rotted wood from underside of leaning, old *Thuja*.

Chaenotheca brunneola (Ach.) Müll. Arg. – *Coffey 5, Lendemer 14314*. Localities 3, 7. On old snag.

Chaenotheca chrysocephala (Ach.) Th. Fr. – *Brodo 32352, Lay 08-0063, Lendemer 14328-A, McMullin 2971.* Localities 3, 7. On *Thuja occidentalis.*

Chaenotheca ferruginea (Turner *ex* Sm.) Mig. – *Lee s.n., Lendemer 14440, 14432, 14139, 14328, Wetmore 97699.* Localities 1, 3, 4, 6, 7. On tree bark including *Thuja* and *Betula*.

Chaenotheca furfuracea (L.) Tibell – *Bennett 20, Lendemer 14546, Lewis 267, 268, McMullin 2970.* Localities 4, 7. On roots of fallen trees and debris on forest floor.

Chaenotheca gracilenta (Ach.) J.-E. Mattsson & Mittelborg [syn. *Cybebe gracilenta* (Ach.) Tibell] – *Lendemer 14545, Lewis 269*. Locality 7. On woody debris on forest floor.

Chaenotheca stemonea (Ach.) Müll. Arg. – *Lewis 264*. Locality 7. On woody debris on forest floor.

Chaenotheca trichialis (Ach.) Th. Fr. – *Lee 2408*. Locality 1. Isolated, exposed tree on lakeside talus slope; *Thuja* bark on base of 150-year-old tree; in bark crevice.

†*Chaenothecopsis debilis* (Turner & Borrer *ex* Sm.) Tibell – *Lendemer 14444*. Locality 6. On wood.

†*Chaenothecopsis pusilla* (Ach.) A.F.W. Schmidt – *Lendemer 14311-B*. Locality 3. On conifer wood.

†*Chaenothecopsis savonica* (Räsänen) Tibell – *Lendemer 14380*. Locality 8. On *Pinus.*

†*Chaenothecopsis viridireagens* (Nádv.) A. Schmidt – *Lewis 227*. Locality 1. On *Chaenotheca* sp. on rotting wood.

Chrysothrix caesia (Flotow) Ertz & Tehler [syn. *Arthonia caesia* (Flotow) Körber] – *Guccion 1285, 1301, Ladd 30254, 30338, Lay 08-0046, Lendemer 14503, Olszewski 6749.* Localities 2, 5, 7. On bark of deciduous and coniferous trees. Recent studies (Nelsen et al. 2009, Ertz and Tehler 2011) indicate that this species, long classified as an *Arthonia*, nests within *Chrysothrix* and is probably a pulvinic acid-deficient member of that genus.

Cladonia atlantica A. Evans. – *Harris 56534*. Locality 12. On decorticate log. This eastern, mainly coastal plain species, known in Canada only from Nova Scotia, is a remarkable disjunction, although it does occur in some eastern montane localities (Lendemer 2009).

Cladonia cariosa (Ach.) Sprengel – *McMullin 2902, Wetmore 97714*. Localities 1, 5. On sand and on soil over limestone.

Cladonia carneola (Fr.) Fr. – *Harris 56525*. Locality 12. On glacial erratic.

Cladonia cenotea (Ach.) Schaerer – *Harris 56524, Lendemer 14429, 14385-A*. Localities 6, 8, 12. On decorticate log.

Cladonia chlorophaea (Flörke *ex* Sommerf.) Sprengel – *Burke s.n., Lendemer 14212, 14179, 14276, 14312, McMullin 2882, 2924, 2957, Wetmore 97618, 97662, 97681, 97807.* Localities 1, 2, 3, 5, 7. On moss, wood and soil.

Cladonia coniocraea (Flörke) Sprengel – *Olszewski 6705, Wetmore 97661.* Localities 1, 2. On dead *Betula.*

Cladonia conista A. Evans [syn. *C. innominata* Lendemer] – *Lendemer 14199*. Locality 1. On humus.

Cladonia crispata (Ach.) Flotow – *Harris 56526*. Locality 12. On duff. This specimen represents the squamatic acid chemotype.

Cladonia cristatella Tuck. – *Lendemer 14173, McMullin 2903, 2960, Wetmore 97701*. Localities 1, 5. On soil.

Cladonia cryptochlorophaea Asahina – *Harris 54910*. Locality 1. Over rock.

Cladonia dahliana Kristinsson – *Harris 54899, 54962, 54963, 54976, 54991, Lendemer 14157, 14458, 14570, 14389*. Localities 1, 5, 6, 7, 8. On soil.

Cladonia deformis (L.) Hoffm. – *Harris 56475*. Locality 8. On soil in wet opening.

Cladonia digitata (L.) Hoffm. – *Harris 56565, 56528, Lendemer 14424, 14434*. Locality 6, 7, 12. On base of *Thuja* and on rotten wood.

Cladonia fimbriata (L.) Fr. – *Harris 54921, Lendemer 14214, 14407, 14113, 14508, McMullin 2927, Wetmore 97672, 97805*. Localities 1, 2, 3, 6, 7. On rotting wood, soil and tree bases.

Cladonia grayi G. Merr. *ex* Sandst. – *Harris 54927, Wetmore 97742*. Localities 2, 6. On base of *Quercus*.

Cladonia humilis (With.) J.R. Laundon – *Harris 54865*. Locality 1. In opening along trail.

Cladonia macilenta Hoffm. var. *bacillaris* (Genth) Schaerer – *Dibble 17714, Wetmore 97694*. Locality 4. On *Thuja* log.

Cladonia macilenta Hoffm. var. *macilenta* – *Burke s.n., Harris 54867, 56562, 56492*. Localities 1, 6, 7, 13. On log, rotten wood and decorticate branch.

Cladonia magyarica Vainio – *Burke s.n., Dibble 17072, 17199*. Localities 1, 5, 6. On humus among limestone cobble, and on limestone pavement.

Cladonia merochlorophaea Asahina – *Harris 54871, 56473, Wetmore 97663*. Localities 1, 2, 8. On charred log and base of pine.

Cladonia mitis Sandst. – *Harris 54973, 54980, 54986, 56476, 56530, Ladd 30309, Lay 08-0064, Lendemer 14472, McMullin 2956, Wetmore 97706*. Localities 5, 6, 8, 14. On sandy soil.

Cladonia multiformis G. Merr. – *Guccion 1304, Lendemer 14408, 14588, 14218, 14387, Wetmore 97724*. Localities 1, 5, 6, 7, 8. On the ground.

Cladonia ochrochlora Flörke – *Burke s.n., Harris 54914, Lendemer 14586, 14578, 14219, 14154, 14261, 14337, McMullin 2881, 2928, 2958, 2973, Wetmore 97655, 97698, 97715, 97802*. Localities 1, 2, 3, 4, 5, 7. On moss and rotting wood. The distinctions between this species and *C. coniocraea* are often difficult (see discussion in Brodo 1968: 189). Typically, *C. ochrochlora* is more corticate in the lower half of the podetium with patchy soralia on the upper half, more uniform in diameter and more frequently cupped.

Cladonia phyllophora Hoffm. – *Harris 54981, 54984, 56529, Hinds 5337, 5338, 5339, Lendemer 14386, McMullin 2929, Olszewski 6789, Wetmore 97718*. Localities 2, 5, 8,14. On soil.

Cladonia pleurota (Flörke) Schaerer – *Freebury 692, Lendemer 14374, 14455, Wetmore 97728*. Localities 6, 8. On soil.

Cladonia pocillum (Ach.) Grognot – *Brodo 32317, Dibble 17096, Harris 54865-A, 54982, 54985-B, 54968, Lendemer 14461-B, Olszewski 6811*. Localities 1, 5, 6, 8. On soil.

Cladonia pyxidata (L.) Hoffm. – *Burke s.n., Guccion 1305, Lendemer 14576, 14156, 14342, 14390, Lewis 250, McMullin 2904, 2945, Wetmore 97691, 97709, 97740*. Localities 1, 4, 5, 6, 7, 8. On soil.

Cladonia rangiferina (L.) F.H. Wigg. – *Burke s.n., Harris 54966, Lay 08-0065, Lendemer 14452, 14126, 14385, 14513, McMullin 2959, 2974, Wetmore 97713*. Localities 1, 5, 6, 7, 8. On soil.

Cladonia scabriuscula (Delise) Nyl. – *Burke s.n., Harris 54872, 55001, Lendemer 14419, 14196, 14155, 14308, 14527, McMullin 2925, 2926, 2972, Wetmore 97762, 97788*. Localities 1, 2, 6, 7. On soil, moss and a snag.

Cladonia squamosa Hoffm. – *Burke s.n., Wetmore 97594*. Localities 1, 6. On soil.

Cladonia stellaris (Opiz) Pouzar & Vězda – *Burke s.n., Ladd 30303, Lendemer 14456, Wetmore 97746*. Locality 6. On soil.

Cladonia subulata (L.) F.H. Wigg. – *Lendemer 14302*. Locality 2. On soil.

Cladonia turgida Hoffm. – *Dibble 17190, Lendemer 14114, 14453, 14388, 14384, McMullin 2955, Wetmore 97704*. Localities 1, 5, 6, 8. On humus beneath *Thuja,* and on sandy soil.

Clauzadea monticola (Ach. *ex* Schaerer) Hafellner & Bellem. – *Buck 54236, Lendemer 14125*. Localities 1, 8. On dolomite. Although described as "arctic-alpine" and "rare" in Brodo et al. (2001) and mapped only from northern Alaska, the Yukon and Greenland in Thomson (1997), this species also occurs in more temperate regions on limestone and concrete. In CANL, there are specimens from coastal British Columbia, Québec (Beauce), New Brunswick (Fundy), Nova Scotia (Annapolis Co. and Cape Breton) as well as nearby Portage Bay, Michigan (Delta Co.), and NY has several specimens from Newfoundland and Labrador, as well as California, Missouri and Tennessee.

Clavascidium lacinulatum (Ach.) M. Prieto [syn. *Placidium lacinulatum* (Ach.) Breuss] – *Guccion 1317, Lendemer 14466, Wetmore 97721, 97735.* Locality 6. On limestone bedrock. Note that our placement of this taxon in *Clavascidium* follows Prieto et al. (2012).

***Clavascidium umbrinum* (Breuss) Breuss** (syns. *Placidium umbrinum* (Breuss) M. Prieto & Breuss, *Catapyrenium umbrinum* Breuss) – *Harris 56542.* Locality 12. On wet or dry soil on alvar. In North American this taxon is known mainly from arid southwest, with disjunct occurrences in open barren habitats in the Great Plains and eastward to Pennsylvania (Breuss 2002, Harris & Ladd 2005, Lendemer 2004). Note that our placement of this taxon in *Clavascidium* follows Prieto et al. (2012).

Cliostomum leprosum (Räsänen) Holein & Tønsberg – Localities 8, 12. *Harris 56483, 56540, Lendemer 14396.* On jack pine bark, near alvars. *Cliostomum leprosum* also occurs in Nova Scotia, New Brunswick, Massachusetts, northern New York, Pennsylvania and Vermont, mostly on conifers but occasionally on hardwoods. The material from the Bruce Peninsula has a well developed hypothallus comparable to that of material from Massachusetts, New York, and Pennsylvania. Although morphologically quite distinct from typical material of this species from the Canadian Maritimes, intermediates do appear to occur and we refer all of the material to *C. leprosum* pending more detailed study.

**Clypeococcum hypocenomycis* D. Hawksw. – *Lendemer 14426* Locality 6. On *Thuja* branch *on Hypocenomyce scalaris*. Surpringsly although this species has been reported from Canada and the United States (Alstrup & Cole 1998, Cole & Hawksworth 2001, Goward & Thor 1992, Triebel et al. 1991) this appears to be first report for Ontario.

Coenogonium pineti (Ach.) Lücking & Lumbsch – *Buck 54133, 54133, 54308, Ladd 30345, Lay 08-0066, 08-0067, 08-0068, Lendemer 14417, 14335, Lewis 244, 245, Wetmore 97796.* Localities 1, 2, 3, 6, 7. Over moss and tree bases.

Collema bachmanianum (Fink) Degel. – *Lendemer 14278*. Locality 2. On soil in forest.

Collema coccophorum Tuck. – *Dibble 17112*. Locality 8. On dolomitic limestone pavement with *Psora decipiens.*

Collema fuscovirens (With.) J.R. Laundon – *Hinds 5314, Ladd 30366, Wetmore 97625, 97748.* Localities 1, 6, 7. On limestone.

Collema limosum (Ach.) Ach. – *Wetmore 97630.* Locality 1. On rock. This is a rare lichen, considered "Vulnerable?" in Canada by Goward et al. (1998).

Collema polycarpon Hoffm. – *Buck 54113*. Locality 1. On shoreside rock.

Collema subflaccidum Degel. – *McMullin 2883, Wetmore 97613, 98849, 97758, 97772*. Localities 1, 6, 7. On trees.

Collema tenax (Sw.) Ach. – *Ladd 30367, Lay 08-0273, Lendemer 14300, 14377, 14530, Lewis 265.* Localities 1, 2, 7, 8. On limestone, often over thin soil accumulations.

Collema undulatum Laurer *ex* Flotow var. *undulatum* – *Hinds 5310, 5312*. Locality 1. On limestone.

Collema undulatum var. *granulosum* Degel. – *Bennett 21, 22, Brodo 32262, 32273, 32319, Buck 54149, 54149, 54261, Hinds 5313, Lay 08-0069, Lendemer 14585, 14123-A, 14123, 14534, 14504, Lewis 266, McMullin 3488*. Localities 1, 2, 6, 7. On limestone.

**Cornutispora ciliata* Kalb – *Harris 56537*. Locality 12. On *Imshaugia aleurites.* This lichen parasite was reported from Québec by Cole and Hawksworth (2001).

Cresponea chloroconia (Tuck.) Egea & Torrente – *Buck 54210, Burke s.n., Harris 54866, 54938, Ladd 30174, Lay 08-0070, Lendemer 14465, 14127-A, 14321, 14483, McMullin 2910, Wetmore 97798.* Localities 1, 3, 4, 6, 7. On tree bark, *Thuja.*

***Dermatocarpon dolomiticum* Amtoft** – *Buck 54271, Burke s.n., Dibble 17077, Guccion 1256, 1314, Harris 55026, Hinds 5316, 5351, Lay 08-0071, 08-0072, 08-0073, 08-0074, , Lendemer 14438, 14574, 14144-A, Lewis 301, 302*. Localities 1, 5, 6, 7, 11. On limestone. This species, recently described from the Ozark region, is apparently found throughout eastern United States (Amtoft et al. 2008), but this is the first Canadian record.

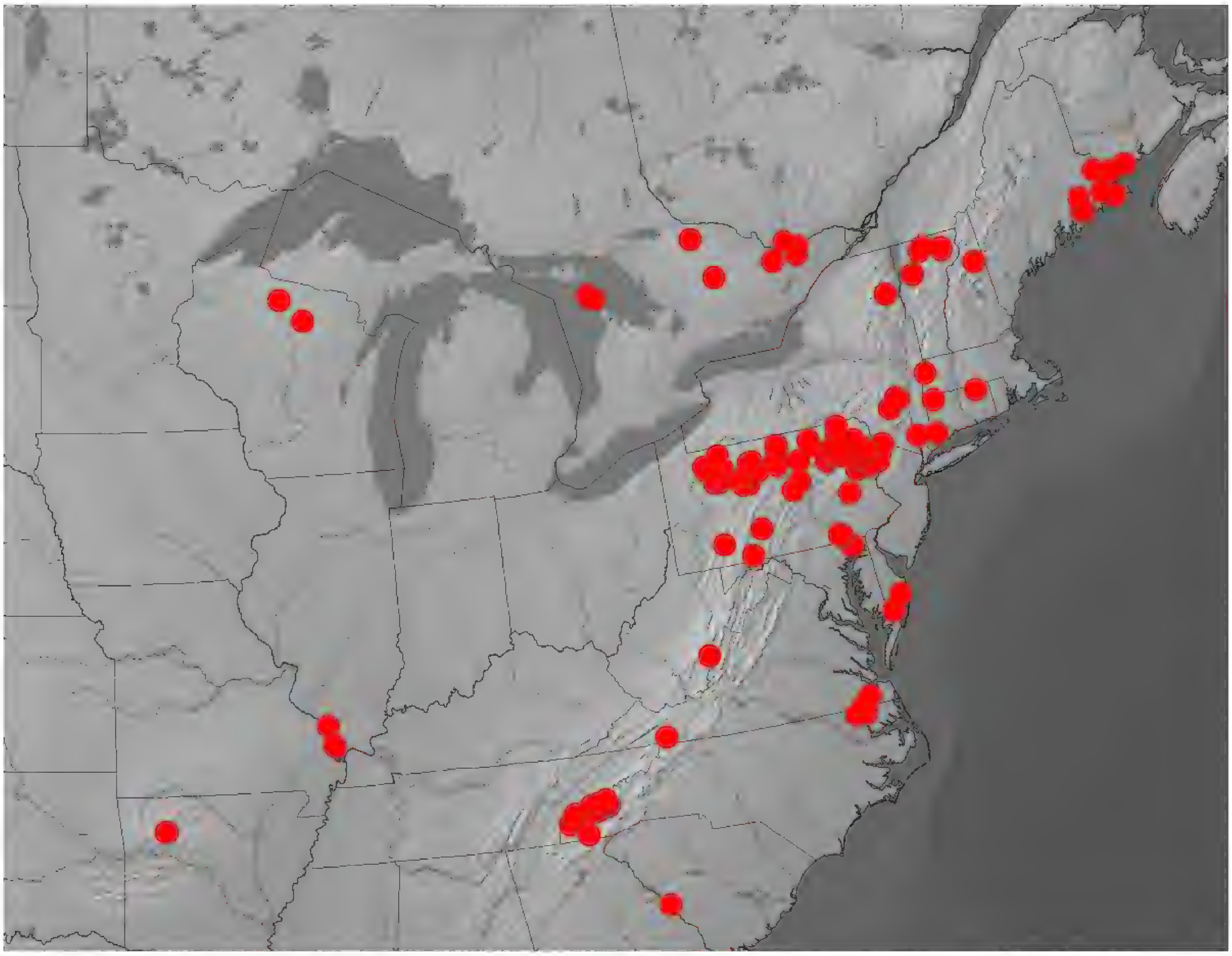

Figure 5, North American distribution of *Dictyocatenulata alba* based on specimens in NY at CANL.

Dermatocarpon miniatum (L.) W. Mann – *Brodo 32258, Bennett 24, Burke s.n., Dibble 17205, Wetmore 97600, 97741, 97777*. Localities 1, 6, 7. On large boulder on beach. It is likely that some of these records represent *D. dolomiticum* or *D. muhlenbergii*. Work is still needed on the correct circumscription of *D. miniatum* s. str., but recent molecular and morphological work indicates it is clearly more limited than was traditionally assumed (see Heiðmarsson & Breuss 2004; Amtoft et al. 2008). We are using the name here for northern material with single, undissected lobes, a smooth lower surface, perithecia under 0.35 mm in diameter and spores (9.0-)12-16(-18) x 5-6(-8.5) µm. *Dermatocarpon americanum* Vainio is a very similar southwestern species.

***Dermatocarpon muhlenbergii* (Ach.) Müll. Arg.** – *Burke s.n., Hinds 5351*. Localities 1, 6. On limestone. Like *D. dolomiticum*, this lichen is common and widely distributed in the eastern United States (Amtoft et al. 2008). Most previous records of *D. miniatum* (L.) W. Mann from eastern North America apparently belong to this taxon. Although vouchers must be checked carefully to confirm they do not represent other taxa treated from Amtoft et al. (2008).

Dictyocatenulata alba Finley & E.F. Morris – *Lendemer 14309-B, 14523*. Localities 3, 7. On *Betula*, especially the base and exposed roots. This lichenized hyphomycete resembling a calicioid lichen was first recorded from North America from several eastern localities, including Ontario, by Seifert et al. (1987), and was shown to be even more widely distributed in the east by Lendemer and Harris (2004) (see Fig. 5). It grows on conifers and hardwoods, usually at the tree base. (See also Diederich et al. 2008.)

Diplotomma alboatrum (Hoffm.) Flotow – *Lendemer 14194, 14498*. Localities 1, 7. On dead *Thuja*.

Diplotomma venustum (Körber) Körber – *Ladd 30229B, 30354, 30358, Lendemer 14586-A*. Localities 1, 7. On rock. This lichen, often classified as a *Buellia* but with 4-celled spores, is common in the central and southwestern United States, but the distribution extends into arctic Canada. In CANL, there are several specimens from Banks Island (Northwest Territories) and Victoria and Ellesmere

Islands (Nunavut), and NY has a few collections from northern Newfoundland (NYBG 2011) as well as Vermont (Lake Champlain) (unpublished). Molecular phylogenetic studies have shown that although not all *Buellia* species with pluriseptate spores fall within *Diplotomma, D. venustum* does (Nordin & Tibell 2005).

**Endococcus nanellus* Ohlert – *Harris 56550*. Locality 12. On *Stereocaulon glaucescens.*

Enterographa zonata (Körber) Källsten *ex* Torrente & Egea [syn. *Opegrapha zonata* Körber] – *Buck 54151*. Locality 1. On rock, Tønsberg and Brodo (1992) reported this species from Nova Scotia as new to North America, although it had been recorded by Eckfeldt (1895), Arnold (1899) and Macoun (1902) from Newfoundland and Labrador. Recent molecular studies have suggested that this species, usually regarded as an *Opegrapha,* is better classified in the genus *Enterographa* (Ertz et al. 2009, Ertz & Tehler 2011).

†*Epigloea pleiospora* Döbbeler – *Buck 54126, Ladd 30201*. Locality 1. On algal film over boulders and humus. This extremely inconspicuous perithecial fungus, often treated with lichens, was first reported from North America by Buck and Harris (2002). It is widespread in the eastern United States and known also from Nova Scotia (NYBG 2011).

Evernia mesomorpha Nyl. – *Burke s.n., Guccion 1257, 1306, 1325, Harris 55013, Ladd 30335, Lay 08-0075, Lendemer 14460, 14540, 14141, 14320, 14381, 14531, McMullin 2911, 2961, 2975, Wetmore 97667, 97717, 97806.* Localities 1, 2, 3, 5, 6, 7, 8. On conifer trees and wood.

Evernia prunastri (L.) Ach. – *Burke s.n., Lewis 237*. Localities 3, 7. Along the edge of a marsh, on a branch tip of a dead conifer. This lichen is common in western North America but very rare in the east ("critically imperilled" in Ontario) and was thought to be extirpated in southern Ontario. It was previously known in southern Ontario only from a John Macoun specimen from the Belleville area that was collected in 1874; also known from a Roy Cain collection from Nakina in the Thunder Bay Area (Crowe 1994).

Farnoldia hypocrita (A. Massal.) Frøberg – *Harris 56568*. Locality 7. On dolomite. New record for Ontario.

Flavoparmelia caperata (L.) Hale – *Harris 54946, Hinds 5333, Ladd 30242, Lendemer 14490, McMullin 2912, Wetmore 97683.* Localities 1, 3, 4, 7. On *Fraxinus* and *Thuja* bark.

Fuscidea arboricola Coppins & Tønsberg – *Hinds 5343, Lendemer 14190, 14427, 14562-A*. Localities 1, 5, 6, 7. On conifer bark.

Fuscidea pusilla Tønsberg – *Harris 54897*. Locality 1. On *Betula papyrifera*. This small sterile sorediate lichen with its striking brown prothallus is undoubtedly under-reported. It was reported for Ontario and fully discussed by Lendemer (2011).

Graphis scripta (L.) Ach. – *Brodo 32337, 32344, Dibble 17117, Guccion 1258, 1326, Ladd 30257, Lay 08-0076, 08-0077, Lendemer 14299, 14315, 14526, McMullin 2884, 2930, Wetmore 97658.* Localities 1, 2, 3, 7. On a variety of deciduous trees.

Gyalecta foveolaris (Ach.) Schaerer – *Buck 54134, Lay 08-0078, Lendemer 14192, 14151*. Locality 1. On humus on rock ledge. This is normally an arctic-alpine species, mainly from the west (Thomson 1997), although there is material from Newfoundland in NY (NYBG 2011).

Gyalecta jenensis (Batsch) Zahlbr. – *Brodo 32290, Buck 54115, 54150, 54324, Guccion 1336, Ladd 30212, Lay 08-0079, Lendemer 14200, 14172, 14155-A, 14496, McMullin 2976.* Localities 1, 2, 4, 7. On shaded and exposed limestone boulders and outcrops.

***Heppia adglutinata* (Kremp.) A. Massal**. – *Harris 54956*. Locality 8. On soil and mosses. *Heppia adglutinata* has long been included within *H. lutosa* (Ach.) Nyl., differing in its heteromerous thallus (Henssen 1994). The former is known from many central, southwestern and southeastern states, whereas the latter was reported from Alberta by Henssen (1994), and there is a specimen from the Kamloops area of British Columbia in CANL. It is also recorded from Saskatchewan by DeVries (unpublished list).

***Heteroplacidium compactum* (A. Massal.) Gueidan & Cl. Roux** [syns. *Verrucaria compacta* (A. Massal.) Jatta, *Catapyrenium compactum* (A. Massal.) R. Sant.] – *Hinds 5332*. Locality 4. In woods, on limestone. This lichen is another striking disjunction, known previously from the southwestern United States (Breuss 2007) and Ozarks (Harris & Ladd 2005.) We follow Prieto et al. (2012) in treating this taxon as a member of *Heteroplacidium* rather than *Verrucaria.*

Hymenelia epulotica (Ach.) Lutzoni – *Bennett 25, Brodo 32270, 32279, Buck 54140, Guccion 1259, 1315, 1337, Harris 54862, 54987, Ladd 30188, Lay 08-0259, Lendemer 14470, 14581, 14169, 14146-A, Lewis 255, Wetmore 97621, 97631, 97732, 97764.* Localities 1, 2, 6, 7. On dolomite limestone.

Hymenelia heteromorpha (Kremp.) Lutzoni – *Lewis 241*. Locality 7. Limestone cliffs and boulders along shoreline, on limestone. This is a remarkable discovery, since *H. heteromorpha* is a high arctic species. Another specimen, collected by Dr. Fred Schueler at Cabot Head in the park, is in CANL together with specimens from the mountains of Alberta, British Columbia, Yukon Territory and Nunavut.

Hypocenomyce anthracophila (Nyl.) P. James & Gotth. Schneider – *Wetmore 97690, 97695*. Locality 4. Shoreline with *Thuja* and black spruce; on stumps.

Hypocenomyce friesii (Ach.) P. James & Gotth. Schneider – *Buck 56557*. Locality 13. On trunk of *Tsuga*.

Hypocenomyce scalaris (Ach.) M. Choisy – *Bennett 26, Buck 54216, Ladd 30310, 30276*, *Lay 08-0080, Lendemer 14432-A, 14425, McMullin 2913, 2952, Wetmore 97675,*. Localities 3, 6. On *Thuja* and *Fraxinus* wood.

Hypogymnia physodes (L.) Nyl. – *Buck 54221,Burke s.n., Dibble 17064, Guccion 1260, 1296, Harris 54874, Hinds 5334, 5341, 5344, 5350, Ladd 30175, Lay 08-0081, 08-0082, Lendemer 14461-A, 14565, 14180, 14168, 14352-A, 14341-A, 14393, Lewis 243, McMullin 2885, 2931, 2962, Olszewski 6703, Wetmore 97573, 97688, 97710, 97799*. Localities 1, 2, 3, 4, 5, 6, 7, 8. On trees, mostly conifers and *Betula*.

Imshaugia aleurites (Ach.) S.F. Meyer – *Brodo 32287, Burke s.n., Freebury 669, Harris 54943, Hinds 5349, Ladd 30277, 30293, Lendemer 14317, McMullin 2914, Wetmore 97684, 97730*. Localities 3, 5, 6. On *Thuja* and *Pinus* bark and wood.

Imshaugia placorodia (Ach.) S.F. Meyer – *Brodo 32299, Dibble 17187, Hinds 5345, 5347, Lendemer 14362*. Localities 5, 8. On *Pinus banksiana*.

†*Julella fallaciosa* (Arnold) R.C. Harris – *Lay 08-00832, Ladd 30258*. Locality 2. On *Acer*.

Lecania cuprea (A. Massal.) van den Boom & Coppins – *Buck 54309, 54315, Harris 54853, Lay 08-0084*. Localities 1, 7. On dolomite. Perhaps the first record for Canada. This biatorine *Lecania* with 3-septate spores and pie-bald apothecia may be more common than it appears. It had been collected on the northern peninsula of Michigan (Drummond Island), probably on part of the same geologic formation as the Bruce Peninsula. It is also known from several localities in Pennsylvania (NYBG 2011) and one locality in Mexico. The species is described in van den Boom (1992) and in the Lichen Flora of the Greater Sonoran Desert Region. The *Bacidia*-like species of *Lecania* are also discussed briefly by Ekman (1996: 41).

Lecania cyrtella (Ach.) Th. Fr. – *Lee 2409p.p.* Locality 3. On *Thuja* lignum.

Lecania naegelii (Hepp) Diederich & van den Boom – *Harris 54870, Lee 2410, Lendemer 14313-B*. Localities 1, 3. On fallen *Populus*, and weathered wood of uprooted *Thuja*.

Lecanora albella (Pers.) Ach. var. *rubescens* (Imshaug & Brodo) Lumbsch – *Brodo 32286, 32312, Buck 54214, 54273, Burke s.n., Dibble 17130, Freebury 666, Guccion 1299, 1307, Harris 54886, 54937, 54951, 54951, Hinds 5335, Ladd 30173, 30260, 30288, 30311, Lay 08-0085, 08-0086, Lendemer 14463-A, 14459, 14135-A, 14339, 14319, 14358-A, 14399, 14520*. Localities 1, 2, 3, 4, 5, 6, 7, 8. On trees.

Lecanora allophana Nyl. f. *sorediata* (Schaerer) Vainio – *Lendemer 14297*. Locality 2. The placement of sorediate *Lecanora subfusca* group populations from eastern North America is somewhat problematical. While the populations cited here would likely have been referred to *L. impudens* Degel. in the past (e.g., Brodo 1984), the morphology and chemistry agree with *L. allophana* f. *sorediata* (cf. Tønsberg 1992). *Hinds 5329, Wetmore 97692, 97703, 97781* from localities 4, 5, 7 were named as *L. impudens,* but are probably the same taxon.

Lecanora argentata (Ach.) Malme – *Burke s.n., Hinds 5330, Wetmore 97665*. Localities 2, 6. Facing open marsh, American elm.

Lecanora caesiorubella Ach. ssp. *caesiorubella* – *Bennett 27, Lewis 304, McMullin 2915, 2942, Wetmore 97685, 97700, 97793*. Localities 1, 3, 4, 5, 7. On wood and bark, especially *Thuja*.

Lecanora carlottiana C.J. Lewis & Śliwa – *Lewis 310*, Locality 1. On limestone. This taxon was recently described from several collections made in Ontario (Lewis & Śliwa 2012).

Lecanora circumborealis Brodo & Vitik. – *Freebury 674, Wetmore 97791*. Localities 1, 2, 3, 4, 6, 7. On *Thuja*. The *Wetmore 97791* specimen is unusual in having a rather thick thallus and pale to medium brown apothecia. It might be an acid-deficient specimen of *L. pulicaris* (with roccellic acid but lacking fumarprotocetraric acid), but the spores are rather large for that species.

Lecanora crenulata Hooker – *Buck 54152, Hinds 5306*. Locality 1. In open on limestone.

Lecanora dispersa (Pers.) Sommerf. – *Bennett 28, Freebury 647, Hinds 5359, 5360, Ladd 30370, Wetmore 97591, 97612, 97619, 96723, 97778*. Localities 1, 7. It is possible that some or all of these records are *L. dispersa* only in the broad sense. The most common member of the *L. dispersa* group on limestone on the Bruce Peninsula is *L. semipallida*.

Lecanora glabrata (Ach.) Malme – *Lewis 290*. Locality 2. On *Acer saccharum* bark.

Lecanora hagenii (Ach.) Ach. – *Bennett 29, Freebury 670, Guccion 1261, Hinds 5323, Lee 2409 p.p., Lendemer 14577, 14151-A*. Localities 1, 2, 3, 7. On lignum.

Lecanora hybocarpa (Tuck.) Brodo – *Burke s.n., Freebury 663, 665,Guccion 1262, 1287, 1327, Lay 08-0087, 08-0088, 08-0090, 08-0091, 08-0092, Lendemer 14275, 14356, Wetmore 97645, 97649, 97784*. Localities 1, 2, 3, 4, 7. On tree bark, especially deciduous trees.

Lecanora meridionalis H. Magn. – *Bennett 30, Brodo 32255, 32288A, Buck 54212, Burke s.n., Guccion 1300, Harris 54892, 54945, Hinds 5330, Lay 08-0093, Lendemer 14316, McMullin 2916, Wetmore 97686*. Localities 1, 2, 3, 4, 5. On lignum and bark of *Picea, Thuja* and *Ulmus*.

Lecanora muralis (Schreber) Rabenh. – *Harris 56538*. Locality 12. On small calcareous rock.

Lecanora polytropa (Hoffm.) Rabenh. – *Ladd 30191, Lendemer 14449*. Localities 1, 6. On siliceous erratic and small siliceous cobbles.

Lecanora pulicaris (Pers.) Ach. – *Brodo 32253, 32253A, 32297, 32311, 32355, Burke s.n., Dibble 17215, Freebury 680, Guccion 1308, Harris 54889, 54996, Hinds 5334, 5346, Lay 08-0094, 08-0095, Lendemer 14463, 14573, 14201, 14182, 14322, 14402, 14399-A, Wetmore 97668, 97716*. Localities 1, 2, 3, 4, 5, 6, 7. On the bark and wood of a variety of trees. This is the most common species of the *Lecanora subfusca* group on the peninsula.

Lecanora rugosella Zahlbr. – *Brodo 32338, Buck 54111, 54123, 54325, Burke s.n., Freebury 648, 671, Guccion 1263, 1328, Harris 54890, 54896, 54936, 54950, Lay 08-0096, 08-0097, Lendemer 14427-A, 14204, 14274, 14326-A, 14358, 14519, Lewis 297, McMullin 2886*. Localities 1, 2, 3, 4, 6, 7, 8. On tree bark and lignum, especially *Thuja* and *Populus*.

Lecanora sambuci (Pers.) Nyl. – *Buck 54220A, Harris 54878, 56581-B, Lay 08-0098, 08-0282, Lendemer 14289-A*. Localities 1, 2, 3, 7. On *Thuja* and *Populus*.

Lecanora semipallida H. Magn. – *Brodo 32261, 32295, 32354, Harris 55010, Lay 08-0277, 08-0099, 08-100, Lendemer 14552, 14542, 14135, 14118, 14368, Lewis 286*. Localities 1, 2, 6, 7, 8. On limestone.

Lecanora subrugosa Nyl. – *Brodo 32267, Hinds 5331, 5333, 5335*. Localities 1, 3, 4. On *Thuja*.

Lecanora symmicta (Ach.) Ach. – *Brodo 32253A, Buck 54211, Guccion 1264, 1288, 1329, Harris 54868, Hinds 5330, Lay 08-0101, 08-0102, 08-0103, Lendemer 14583, 14124-A, 14341, 14401, Lewis 300*. Localities 1, 2, 3, 4, 5, 7, 8, 11. On bark and wood of various trees.

Lecanora thysanophora R.C. Harris – *Buck 54220, Freebury 661B, Harris 54928, 54932, Hinds 5325, Ladd 30164, Lay 08-0104, 08-0105, Lendemer 14284-A, 14324, 14492, Lewis 296, McMullin 2887, 2963, Olszewski 6761, Wetmore 97656, 97795*. Localities 1, 2, 3, 5, 7. On bark of *Acer saccharum, Fraxinus, Pinus, Populus* and *Thuja*. It is very unusual to find *L. thysanophora* on conifer bark, but the specimen on pine had the typical fibrous prothallus showing a grey line (McMullin, personal communication).

Lecanora wisconsinensis H. Magn. – *Wetmore 97809*. Locality 7. Substrate not given.

Lecidea atrobrunnea (Lam. & DC.) Schaerer – *Lendemer 14449-B*. Locality 6. Like *Hymenelia heteromorpha, Lecidea atrobrunnea* is a disjunct from the high arctic. It has also been recorded, however, from Isle Royale and the Slate Islands in Lake Superior (Thomson 1997). It was found on a siliceous erratic rock lying on the alvar surface. The specimen contained confluentic acid.

Lecidea brunneofusca H. Magn. – *Lewis 309*. Locality 6. On a granite boulder in full sun on a shoreline alvar with scattered trees.

Lecidella carpathica Körber – *Wetmore 97629*. Locality 1. On rock.

Lecidella elaeochroma (Ach.) M. Choisy – *Ladd 30330, Lay 08-0278, Lendemer 14133-B, Wetmore 97608*. Localities 1, 3. On *Thuja*.

Lecidella stigmatea (Ach.) Hertel & Leuckert – *Buck 54267, Harris 55014, Ladd 30320, Lay 08-0150 B, 08-0266, Lendemer 14128-A, 14476, 14449-A, 14540-A, 14117, 14303-A, 14271, 14349, Lewis 256*. Localities 1, 2, 4, 6, 7. On limestone.

Leimonis erratica (Körber) R.C. Harris & Lendemer [syn. *Micarea erratica* (Körber) Hertel, Rambold & Pietschmann] – *Buck 54145*. Locality 1(-2). On boulder with *Porpidia crustulata*. The genus *Leimonis* is described and fully discussed in Harris (2009).

Lempholemma isidiodes (Nyl. *ex* Arnold) H. Magn. – *Beeching 6716* (det. Schultz) Locality 1. On limestone cliff. This rare lichen is known from northern British Columbia (Brodo et al. 1987).

Lempholemma polyanthes (Bernh.) Malme [syn. *L. myriococcum* (Ach.) Th. Fr.] – *Lee 2411*. Locality 1. Sheltered side of exposed shoreside limestone bluff, on moss over soil on rock. Rare in southern Ontario (Wong and Brodo 1992 as *L. myriococcum*). Considered "Vulnerable?" in Canada by Goward et al. (1998). It has a scattered, widespread distribution based on specimens in North American herbaria (CNALH 2011) but is easily overlooked.

Lepraria caesiella R.C. Harris – *Harris 54884, Lendemer 14150-A, 14423, 14544, 14283, 14355*. Localities 1, 2, 4, 6, 7. On the bark of *Pinus* and *Betula* and on lignum. This may be the first cited record for Ontario, although there are several Ontario collections in CANL, and Harris (*in* Lendemer 2005: 51) mentions it as occurring in southern Canada. It is common in eastern North America.

Lepraria disjuncta Lendemer – *Lendemer 14136-B, 14571, 14569*. Localities 1, 7. This species was recently described from numerous disjunct localities in eastern North America where it is restricted to calcareous rock substrates (Lendemer 2010). Flowerpot Island is the type locality.

Lepraria eburnea J.R. Laundon – *Harris 54913, 54970, Lay 08-0036, Lendemer 14139-A, 14439, 14422, 14287-A, 14331, 14357, 14354, 14367*. Localities 1, 2, 3, 4, 5, 6, 8. On bark, especially *Thuja*, and on wood and humus. The species is known elsewhere in Canada from British Columbia (Qian and Klinka 1998) and Nova Scotia (F. Anderson, personal communication.). There are specimens from Maine, New Hampshire and Vermont in NY (NYBG 2011).

Lepraria elobata Tønsberg – *Lendemer 14330*. Locality 3. On *Betula* root.

Lepraria finkii (B. de Lesd.) R.C. Harris [syn. *L. lobificans* auct.] – *Buck 54270, Burke s.n., Freebury 687, Guccion 1265, Harris 54860, 54883, Hinds 5311, Lay 08-0106, 08-0106, Lendemer 14447, 14566, 14555,14184,14157-A,14148-A,14140-A,14308-D,14307-A,14291,14265,14263,14337-B,14336,14330, 14333,14344,14512, McMullin 2932, 2977, Wetmore 97579, 97786*. Localities 1, 2, 3, 4, 6, 7. On shaded rocks, wood and tree bases. Note that following Lendemer (2010) we adopt the name *Lepraria finkii* for the taxon that has long been misidentified as *L. lobificans* Nyl. throughout the world.

Lepraria neglecta (Nyl.) Erichsen – *Harris 54949* (alectorialic acid), *56539* (roccellic acid), *Lendemer 14392* (alecotorialic acid). Localities 4, 8, 12. On glacial erratic boulder.

Lepraria torii Pérez-Ortega & T. Sprib. – *Lendemer 14185, 14331, 14354*. Localities 1, 3. On *Thuja* bark. This species has been reported from eastern North America, including the Bruce Peninsula, by Lendemer (2010). It is common in the coastal Pacific Northwest (Pérez-Ortega & Spribille 2009).

Leptogium intermedium (Arnold) Arnold – *Lendemer 14418*. Locality 6. On humus. This species is known from northern Manitoba (Piercey-Normore 2006) as well as Wisconsin (Thomson 2003). There is also a record from Nova Scotia (Anderson & Neily 2010).

Leptogium lichenoides (L.) Zahlbr. –*Bennett 31, Brodo 32257, 32296B, Buck 54116, 54116, 54312, Harris 54882, 55030, Hinds 5319, Ladd 30216, 30223, Lay 08-0107, Lendemer 14130, 14375, 14517, Lewis 261, McMullin 3486, Wetmore 97614, 97765, 97780*. Localities 1, 2, 6, 7, 8. On limestone, usually in moss clumps.

Leptogium teretiusculum (Wallr.) Arnold – *Ladd 30223, McMullin 3487* (det. Brodo). Locality 1. On *Acer* bark at the tree base.

†*Leptorhaphis epidermidis* (Ach.) Th. Fr. – *Brodo 32345, Ladd 30159, Lay 08-0108, Wetmore 97652*. Localities 2, 7. On bark of *Betula*.

**Lettauia cladoniicola* D. Hawksw. & R. Sant. – *Brodo 32305B, Buck 54254, Ladd 30205*. Localities 5, 6. On *Cladonia mitis* under pine. This species is likely widespread in North America but undercollected because of its small size and occurrence on the basal portions of the podetia of *Cladonia*. It has been reported from the southern Appalachian Mountains in the United States (Esslinger & Egan 1995, Ihlen & Tønsberg 1996) and from Newfoundland in Canada (Diederich 2003). Here we provide the first report for Ontario.

**Leucogyrophana lichenicola* Thorn, Malloch & Ginns – *Buck 54250*. Locality 5. On *Cladonia rangiferina*.

***Lichenoconium erodens* M.S. Christ. & D. Hawksw.** – *Harris 54856-A, 55011*. Localities 1, 7. On thallus of *Hypogymnia physodes* and *Cladonia ochrochlora*. First published record for Canada, although known also from Nova Scotia and New Brunswick (Clayden, unpublished)

Lichinella nigritella (Lettau) P.P. Moreno & Egea – *Wetmore 97756*. Locality 7. On limestone boulders.

**Lichenodiplis lecanorae* (Vouaux) Dyko & D. Hawksw. – *Buck 54205, Harris 56578, Ladd 30269*. Localities 3, 7. On *Caloplaca holocarpa* and *Lecanora albella* var. *rubescens*. First records for Ontario, but widespread in temperate North America (CNALH 2011, NYBG 2011). Diederich (2003) reported the species from Québec.

***_Lichenosticta alcicorniaria_ (Lindsay) D. Hawksw.** – *Harris 54974, 55016, 56470*. Localities 1, 5, 7. On *Cladonia dahliana, C. pocillum* and *C. pyxidata*. *Lobaria pulmonaria* (L.) Hoffm. – *Lendemer 14493, McMullin 2888*. Localities 1, 7. On *Acer saccharum*.

Lobaria quercizans Michx. – *Burke s.n., Wetmore 97648*. Locality 2. On *Acer saccharum*.

Loxospora elatina (Ach.) A. Massal. – *Lendemer 14486*. Locality 7. On *Thuja*.

Loxospora ochrophaea (Tuck.) R.C. Harris – *Buck 54208*. Locality 3. On dead *Thuja*.

**Marchandiomyces corallinus* (Roberge) Diederich & D. Hawksw. [syn. *Illosporium corallinum* Roberge] – *Lendemer 14121, 14289*. Localities 1, 2. On *Physcia adscendens* on fallen *Populus* branch. This lichenicolous basidiomycete is superficially very similar to the Hypocrealean ascomycetes *Illosporium* and *Illosporiopsis*. The species was reported from Canada (Québec) by Cole and Hawksworth (2001) and this appears to be the first report for Ontario.

Montanelia sorediata (Ach.) Divakar et al. – *Guccion 1316*. Locality 6. On erratic boulder.

Melanelixia fuliginosa (Fr. ex Duby) O. Blanco et al. – *Brodo 32324, Harris 54876, 55029, Lendemer 14134-A, 14292, 14266, 14400*. Localities 1, 2, 7, 8. On *Populus* and *Thuja*.

Melanelixia subaurifera (Nyl.) O. Blanco et al. – *Hinds 5325, 5330, Ladd 30167, 30251, Lay 08-0109, 08-0110, 08-0111, 08-0112, Lendemer 14127, 14547, 14341-B, McMullin 2890, 2933, 2978, Olszewski 6816, 6744, Wetmore 97659, 97711, 97808, 97811*. Localities 1, 2, 4, 5, 6, 7. On tree bark, mainly deciduous species, or on wood.

Micarea elachista (Körber) Coppins & R. Sant. – *Lewis 307*. Locality 1. On rotting charred stump.

Micarea peliocarpa (Anzi) Coppins & R. Sant. – *Brodo 32250, 32252, 32291, 32334, Buck 54110, 54110, 54122, 54122, 54125, 54125, 54228, 54228, Harris 54861, 54904, 54933, 55002, Lay 08-0113, 08-0114, Lendemer 14473, 14138-A, 14122-A, 14332-A, 14532, Lewis 232, McMullin 2943, Olszewski 6784, Wetmore 97576, 97595, Ladd 30279*. Localities 1, 2, 3, 4, 5, 6, 7, 8, 9. On rotting wood, logs, tree bases, occasionally soil.

Micarea prasina Fr. – *Guccion 1266, Harris 54902, 54934, Lay 08-0115*. Localities 1, 2, 7. On base of *Thuja occidentalis* or on logs.

**Muellerella erratica* (A. Massal.) Hafellner & V. John – *Harris 54999*. Locality 6. On *Protoblastenia rupestris*. First record for Ontario. It was recently reported from California by Knudsen and Kocourková (2009) who pointed out that the species was known in the literature as *M. pygmaea* var. *athallina* (Müll. Arg.) Triebel. It had been reported from Nunavut under that name.

***_Muellerella hospitans_ Stizenb**. – *Harris 54918-A*. Locality 2. On *Bacidia rubella*. This parasite was known from Minnesota and southeast Alaska (Spribille et al. 2010).

**Muellerella lichenicola* (Sommerf. *ex* Fr.) D. Hawksw. – *Lewis 282B*. Locality 7. On *Caloplaca flavovirescens*.

***_Muellerella ventosicola_ (Mudd) D. Hawksw.** – *Lay 08-0264*. Locality 7. On *Rhizocarpon*. *Multiclavula mucida* (Fr.) R. Petersen – *Brodo 32347*. Locality 7. On rotting stump.

Mycobilimbia berengeriana (A. Massal.) Hafellner & V. Wirth [syn. *Lecidea berengeriana* (A. Massal.) Th. Fr.] – *Buck 54138*. Locality 1(-2). On humus.

Mycobilimbia carneoalbida (Müll. Arg.) S. Ekman – *Brodo 32328, Buck 54139, 54139, Harris 54929, Lendemer 14550, 14160, Lewis 272*. Localities 1, 2, 7. On moss on boulders and tree bases.

Mycobilimbia hypnorum (Lib.) Kalb & Hafellner [syn. *Lecidea sanguineoatra* auct.] – *Brodo 32264B, 32265, 32325, Buck 54144, 54144, 54252, 54304, 54316, 56526, Lendemer 14467, 14454, 14420, 14152-A, 14142-A, 14137-A, Lewis 299, 303, Wetmore 97593, 97722*. Localities 1, 2, 5, 6, 7, 8. On soil over limestone at edge of beach, bryophytes over sand and limestone, or on soil.

†*Mycocalicium subtile* (Pers.) Szatala – *Buck 54114, 54114, Freebury 657, Harris 54879, Ladd 30185, 30236, 30256, 30313, Lendemer 14140, 14475-A, 14406, 14140, Lewis 228, McMullin 2891, 2917, 2944, Wetmore 97790*. Localities 1, 2, 3, 4, 6, 7. On lignum.

†_Mycoglaena myricae_ (Nyl.) R.C. Harris – *Buck 54213, Ladd 30265*. Locality 3. On *Myrica gale*. Although there do not appear to be any formally previously published reports of this species from Canada, a collection from Nova Scotia was distributed by Vězda (1977) in the *Lichenes Selecti Exsiccati*.

Myelochroa aurulenta (Tuck.) Elix & Hale – *Hinds 5322, Lay 08-0116*. Localities 2, 3. Bark of litterfall.

**Nectriopsis parmeliae* (Berk. & M.A. Curtis) M.S. Cole & D. Hawksw. – *Harris 54856, 54859, 55022, Lendemer 14181, 14511.* Localities 1, 7. On *Hypogymnia physodes* and *Parmelia sulcata.*

Ochrolechia androgyna (Hoffm.) Arnold – *Burke s.n.* Locality 6. On cedar bark.

Ochrolechia arborea (Kreyer) Almb. – *Brodo 32284, Buck 54204, Guccion 1267, 1309, Harris 54947, 54975, Ladd 30268, Lay 08-0117, Lendemer 14412, 14208, 14304-A, 14259, 14345-A, 14401-A, Wetmore 97720.* Localities 1, 2, 3, 4, 5, 6, 8. On bark of various trees.

Opegrapha dolomitica (Arnold) Körber – *Lendemer 14154-A, 14156-A, 14174.* Locality 1. On rock overhangs. The genus *Opegrapha* is in great need of a North American revision, as can be seen from the report of several rare species just from the Bruce Peninsula. *Opegrapha dolomitica* was reported for Ontario (based on the Bruce record) and Newfoundland by Lendemer et al. (2009). It is found throughout the British Isles, Scandinavia, and southeastern Europe (Pentecost and James 2009, Santesson 1993, Abbott 2009).

***Opegrapha mougeotii* A. Massal.** – *Buck 54307.* Locality 7. On dolomite. This is the first published record for Canada. The species was first reported from North America by Harris and Ladd (2005) based on tentatively identified specimens from the Missouri Ozarks. There are also specimens from Kansas and Kentucky (CNALH 2011), and Oklahoma and Texas (D. Ladd, personal communication). It is widely distributed in Europe and elsewhere. There is a good description of the species in Pentecost and James (2009).

Opegrapha rufescens Pers. – *Lendemer 14143, 14284-B, Lewis 271.* Localities 1, 2. On *Populus.* This taxon is also known from Haida Gwaii (Queen Charlotte Islands), British Columbia (Noble et al. 1987), and there are specimens from New Jersey and Missouri in NY.

Opegrapha vulgata Ach. – *Brodo 32353, Lay 08-0275.* Locality 7. On *Thuja occidentalis.* First modern records for Ontario. *Opegrapha vulgata* is primarily a coastal plain and Ozark species in North America, although it is also known from southern California. There are old records from Newfoundland and Labrador, British Columbia, Ontario and Québec (Arnold 1899, Eckfeldt 1895, Macoun 1902, 1906), but these should be verified because the name may have been used very broadly.

Parmelia squarrosa Hale –*Ladd 30239, 30241, Olszewski 6753.* Localities 1, 2. On *Fraxinus* and *Ulmus.*

Parmelia sulcata Taylor – *Burke s.n., Dibble 17094, Guccion 1268, 1310, Hinds 5330, 5334, Lendemer 14421, 14559, 14213, 14329, 14352, McMullin 2892, 2893, 2934, 2935, 2964, 2981, Olszewski 6698, Wetmore 97646, 97687, 97794.* Localities 1, 2, 3, 4, 5, 6, 7. On deciduous and coniferous trees and wood.

Parmeliopsis ambigua (Wulfen) Nyl. – *Bennett 32, Buck 54260, Hinds 5344, McMullin 2918, 2946, Wetmore 97726.* Localities 3, 5, 6, 8. On conifers.

Parmeliopsis capitata R.C. Harris *ex* Hinds & Hinds – *Buck 54251, Hinds 5343, 5365, Lay 08-0118.* Localities 5, 7. On twigs of *Pinus.*

Peltigera aphthosa (L.) Willd. – *Bennett 33.* Locality 7. On moss over soil.

Peltigera canina (L.) Willd. – *Bennett 33, Guccion 1269, 1330, Wetmore 97626, 97666, 97693, 97804.* Localities 1, 2, 4, 7. On soil and moss.

Peltigera elisabethae Gyelnik – *Harris 54880, 54907, 55018, Ladd 30199, 30200, 30280, 30381, Lendemer 14120, 14524, Olszewski 6711, 6754, Wetmore 97574, 97586.* Localities 1, 2, 7. On soil, moss and tree bases.

Peltigera evansiana Gyelnik – *Harris 54903, Lendemer 14217, 14273, 14533, Lewis 251, McMullin 2983, Olszewski 6833, 6755, Wetmore 97785.* Localities 1, 2, 7. Over moss, soil, detritus and tree bases.

Peltigera horizontalis (Hudson) Baumg. – *Lewis 249.* Locality 7. Over moss, soil, detritus.

Peltigera leucophlebia (Nyl.) Gyelnik – *Lewis 252.* Locality 7. Over moss.

Peltigera polydactylon (Necker) Hoffm. – *Wetmore 97783.* Locality 7. Substrate not given.

Peltigera praetextata (Flörke *ex* Sommerf.) Zopf – *Harris 54887, 54919, 54978, 55024, Ladd 30161, Lay 08-0119, Lendemer 14138, 14306, 14260, 14343, 14482, McMullin 2894, 2895, 2936, 2937, 2965, 2982, Olszewski 6697.* Localities 1, 2, 4, 5, 7. On soil and moss.

Peltigera rufescens (Weiss) Humb. – *Brodo 32268, Burke s.n., Dibble 17152, Guccion 1270, 1331, Harris 54954, 54969, 54971, Ladd 30193, Lay 08-0120, 08-0281, Lendemer 14416, 14548, 14197, 14115, Olszewski 6696, Wetmore 97707, 97745.* Localities 1, 2, 5, 6, 7, 8. On soil.

Pertusaria consocians Dibben – *Ladd 30259, Lendemer 14312-A.* Localities 2, 3. On *Acer* and *Thuja.*

Pertusaria macounii (I.M. Lamb) Dibben –*Lay 08-0122, Lendemer 14336-A, 14518, Lewis 295.* Localities 2, 3, 7. On *Acer saccharum* bark.

†*Phaeocalicium polyporaeum* (Nyl.) Tibell – *Lewis 229*. Locality 1. On polypore (*Trichaptum biforme*).

†*Phaeocalicium populneum* (Brond. *ex* Duby) A.F.W. Schmidt – *Brodo 32266, Hinds 5326, Ladd 30250, Lay 08-0123, Wetmore 97660*. Localities 1, 2. On *Populus*.

Phaeophyscia adiastola (Essl.) Essl. – *Brodo 32293, Harris 54901, 55028, Hinds 5320, 5357, Ladd 30197, 30360, Lendemer 14163, 14528, Lewis 292, Wetmore 97769*. Localities 1, 2, 6, 7. On both bare and mossy limestone, sometimes shaded.

Phaeophyscia ciliata (Hoffm.) Moberg – *Guccion 1271*. Locality 1. On *Populus tremuloides*.

Phaeophyscia hirsuta (Mereschk.) Essl. – *Guccion 1272*. Locality 1. On limestone bedrock of cliff-top.

Phaeophyscia kairamoi (Vainio) Moberg – *Ladd 30346, Wetmore 97763*. Locality 7. On limestone cliffs and boulders.

Phaeophyscia orbicularis (Necker) Moberg – *Hinds 5359, 5360, Lendemer 14147-A*. Localities 1, 7. On limestone.

Phaeophyscia pusilloides (Zahlbr.) Essl. – *Dibble 17113, Harris 54931, Hinds 5321, Guccion 1289, Lendemer 14295, 14279, 14334, McMullin 2939, Wetmore 97670*. Localities 2, 3. On *Acer saccharum* and rock.

Phaeophyscia rubropulchra (Degel.) Essl. – *Dibble 17115, Guccion 1290, Hinds 5325, 5328, Lendemer 14205, McMullin 2938, Wetmore 97671*. Localities 1, 2. On sugar maple.

Phaeophyscia sciastra (Ach.) Moberg – *Brodo 32294, Hinds 5360, Ladd 30347, 30353, Lendemer 14489*. Localities 6, 7. On alvar limestone rocks and cliff faces.

******Phaeopyxis punctum*** **(A. Massal.) Rambold, Triebel & Coppins** – *Harris 54985-A, 56474*. Localities 5, 8. On *Cladonia pocillum* and *C. merochlorophaea*.

**Phaeosporobolus alpinus* R. Sant., Alstrup & D. Hawksw. – *Harris 54944*. Locality 3. On *Ochrolechia arborea*.

Phlyctis argena (Sprengel) Flotow – *Burke s.n., Guccion 1273, 1291, Harris 54911, Lay 08-0124, 08-0125, Lendemer 14415, 14187, 14277, 14267, 14332, 14347, 14501, McMullin 2985, Wetmore 97589, 97789*. Localities 1, 2, 3, 4, 6, 7. On trunks of *Thuja occidentalis* and *Acer saccharum*.

******Phoma cladoniicola*** **Diederich, Korcourc. & Etayo** – *Buck 54186, Harris 56506*. Locality 2, 13. On *Cladonia ochrochlora* (*Buck 54186*) and *C. pocillum* (*Harris 56506*). This type specimen of this species is from material collected on *Cladonia pyxidata* in Minnesota and it has also been reported from throughout Europe (Czech Republic, France, Germany and Spain) (Diederich et al. 2007). Our collections appear to be only the second and third records for North America.

Physcia adscendens (Fr.) H. Olivier – *Brodo 32280, Buck 54223, Harris 55017, Hinds 5324, 5330, 5360, Guccion 1274, 1292, Ladd 30384, Lay 08-0126, 08-0127, 08-0128, Lendemer 14146, 14143-A, 14301, 14289-B, 14487, McMullin 2897, Wetmore 97644, 97766*. Localities 1, 2, 3, 7. On trees and wood, occasionally rock.

Physcia aipolia (Ehrh. *ex* Humb.) Fürnr. – *Burke s.n., Guccion 1275, 1293, Harris 54900, Lay 08-0129, Lendemer 14313-A, 14503-B, McMullin 2898*. Localities 1, 2, 3, 7. On *Populus*.

Physcia americana G. Merr. – *Lewis 257*. Locality 7. Over moss and limestone.

Physcia caesia (Hoffm.) Fürnr. – *Ladd 30350, Lendemer 14153-A, Lewis 239*. Localities 1, 7. On limestone.

Physcia dubia (Hoffm.) Lettau – *Wetmore 97739*. Locality 6. Substrate not given.

Physcia millegrana Degel. – *Hinds 5330, Lendemer 14311-A, 14309, Wetmore 97643*. Localities 2, 3. On *Ulmus* and *Acer*.

Physcia stellaris (L.) Nyl. – *Guccion 1276, 1294, Harris 55025, Hinds 5327, Ladd 30168, Lendemer 14143-B*. Localities 1, 2, 7. On *Acer* and *Populus*.

Physconia detersa (Nyl.) Poelt – *Hinds 5361, Ladd 30240, Lay 08-0131, Lewis 289, Olszewski 6748*. Localities 1, 2, 7. On *Acer, Ostrya, Thuja* and *Ulmus*.

Physconia enteroxantha (Nyl.) Poelt – *Lay 08-0132, Lendemer 14282, 14506*. Localities 2, 4, 7. On trees.

Physconia leucoleiptes (Tuck.) Essl. – *Wetmore 97596, 97640, 97654*. Localities 1, 2. On *Thuja, Ostrya* and *Acer saccharum*.

Physconia muscigena (Ach.) Poelt – *Lendemer 14191, Lewis 226, 254*. Localities 1, 7. On soil.

Placidium squamulosum (Ach.) Breuss – *Bennett 38, 39, Buck 54242, Dibble 17210, Freebury 679, Harris 54955, 54988, 54989, 54995, Lay 08-0130, Lendemer 14471, 14462, 14376, McMullin 2947*. Localities 5, 6, 8, 13. On soil. First published record for Ontario. This species, widely distributed in the western and central parts of the continent, is also found in suitable habitats in the east. In

CANL, there is another specimen from Ontario (Hastings Co., *Wong 2387*), one from Québec and one from the Chaumont Barrens, an alvar near Watertown in New York State.

Placynthiella icmalea (Ach.) Coppins & P. James – *Buck 54311, Wetmore 97736*. Localities 6, 7. On wood.

Placynthiella oligotropha (J.R. Laundon) Coppins & P. James – *Lay 08-0134*. Locality 7. On soil.

Placynthium nigrum (Hudson) Gray – *Bennett 40, Buck 54141, 54141, Lay 08-0133, Freebury 649, 656, Guccion 1277, Hinds 5309, Ladd 30189, Lendemer 14468, 14453, 14120-A, 14298, 14279-A, 14359, Wetmore 97588, 97737*. Localities 1, 2, 4, 6, 7. On limestone and dolomite.

Platismatia tuckermanii (Oakes) Culb. & C. Culb. – *Wetmore 97725*. Locality 6. On *Thuja*.

******Plectocarpon cladoniae*** **R. Sant.** – *Harris 54985*. Locality 5. On *Cladonia pocillum*.

Polyblastia cupularis A. Massal. – *Guccion 1341, Harris 55006, Ladd 30375, Lay 08-0135*. Localities 1, 7. On limestone.

******Polycoccum minutulum*** **Kocourk. & F. Berger** – *Lendemer 14440-B*. Locality 6. On glacial erratic, on *Trapelia placodioides*. It is doubtful that this parasite is largely restricted to Pennsylvaia and nearby New York as one might suppose by looking at the records in NY. More likely, it is widespread, at least in the east, and has simply been collected everywhere within the range of the host taxon that someone has looked for it.

Porpidia albocaerulescens (Wulfen) Hertel & Knoph – *Wetmore 97592*. Locality 1.

Porpidia contraponenda (Arnold) Knoph & Hertel – *Lendemer 14441, 14365-A*. Localities 6, 8. On glacial erratics. This is primarily a western species known from Alaska to California, although it was recently found at Chignecto Bay, Nova Scotia (Anderson, personal communication) and was reported from Pennsylvania by Lendemer (2009).

Porpidia crustulata (Ach.) Hertel & Knoph – *Harris 54923, Ladd 30233, Lay 08-0274, Lendemer 14304*. Localities 1, 2. On siliceous glacial erratic boulders and stones.

Porpidia macrocarpa (DC.) Hertel & A.J. Schwab f. *nigrocruenta* (Anzi) Fryday – *Harris 56482, Lendemer 14348*. Localities 4, 8. On glacial erratic. This *forma* is listed for British Columbia in Qian and Klinka (1998) but as a synonym of *P. macrocarpa*. It is known from a number of localities in the Appalachians based on specimens in NY. Fryday (2005) cites it from South Dakota and describes its distinction from f. *macrocarpa*.

Porpidia soredizodes (Lamy *ex* Nyl.) J.R. Laundon – *Lendemer 14497*. On rock. Locality 7. Gowan (1989) tentatively reported this species from New Brunswick and Newfoundland and Labrador, and these reports were confirmed by Fryday et al (2007), who discussed in detail the status of the species in North America.

Porpidia superba (Körber) Hertel & Knoph [syn. *P. calcarea* Gowan] – *Beeching 6704*. Locality 8. In alvar, on limestone. This is one of the few species of *Porpidia* that grows on calcareous rock. It is an arctic species known from the Northwest Territories (Gowan 1989, Thomson 1997), but also has been found in Keweenaw County in northern Michigan (CANL).

Porpidia tuberculosa (Sm.) Hertel & Knoph – *Guccion 1318, Lendemer 14440-A*. Locality 6. On erratic boulder.

**Pronectria robergei* (Mont. & Desm.) Lowen – *Harris s.n.* Locality 1. On *Peltigera praetextata*. Known from British Columbia and the United States (Alstrup and Cole 1998).

Protoblastenia rupestris (Scop.) J. Steiner – *Bennett 42, 43, Brodo 32323, Buck 54129, 54129, Freebury 646, Guccion 1278, 1342, Harris 54967, 55015, Hinds 5306, 5354, 5367, 5368, Ladd 30210, Lay 08-0136, 08-0137, 08-0257, Lendemer 14469, 14543, 14189, 14129-A, 14303, 14370, McMullin 2899, Wetmore 97622, 97753, 97761*. Localities 1, 2, 6, 7, 8. On limestone.

Protoparmelia hypotremella van Herk, Spier & V. Wirth – *Lay 08-0149, Lendemer 14305-A, 14431-B, 14563, 14562, McMullin 2920*. Localities 2, 3, 4, 6, 7. This species was recently reported as new for North America from northern Ontario (Brodo & Aptroot 2005).

Pseudevernia consocians (Vainio) Hale & W.L. Culb. – *Bennett 44, Buck 54259, Burke s.n., Dibble 17209, Freebury 684, Hinds 5352, Ladd 30290, 30292, Lay 08-0138, Lendemer 14477, Lewis 277, Olszewski 6776, Wetmore 97727*. Localities 3, 6. On *Larix, Pinus* and *Thuja*.

Pseudosagedia aenea (Wallr.) Hafellner & Kalb [syn. *Porina aenea* (Wallr.) Zahlbr.] – *Clayden 19443* p.p. Locality 7. On *Acer spicatum*. In Canada, this lichen is listed only from coastal British Columbia (Qian & Klinka 1998), although there are specimens from Nova Scotia, Massachusetts and Pennsylvania in NY (NYBG 2011). It has also been reported from the Channel Islands of California (Aptroot 2002).

Psora decipiens (Hedw.) Hoffm. – *Bennett 45, 46, Brodo 32296A, 32306, Burke s.n., Buck 54237, 54274, Dibble 17140, 17213, Harris 54957, 54994, Ladd 30307, Lay 08-0139, Lendemer 14478, Lewis 279, 280, Wetmore 97734.* Localities 6, 8, 13. On soil over limestone.

Psora pseudorussellii Timdal – *Bennett 47, Brodo 32322, Burke s.n., Guccion 1343, Hinds 5366, Lendemer 14137, McMullin 2905, Wetmore 97575, 97605.* Localities 1, 7. On moss over rock.

Psorotichia schaereri (A. Massal.) Arnold – *Bennett 48, Brodo 32272, Dibble 17159.* Locality 1. *Psorotichia schaereri* is restricted to calcareous rocks and is common in the southwestern United States with scattered occurences extending into eastern United States. This is only the second Canadian record, the other being from the Québec part of the Ottawa region (Brodo 1981).

Punctelia caseana Lendemer & Hodkinson – *Harris 56575, Ladd 30291, 30328.* Localities 6, 7. On *Larix* and *Thuja*. Most records of *Punctelia subrudecta* (Nyl.) Krog from eastern North America belong to this species (Lendemer & Hodkinson 2010). The *P. subrudecta* group has a long and complex nomenclatural history, as pointed out by these authors.

Punctelia rudecta (Ach.) Krog – *Burke s.n., Freebury 696, Guccion 1279, Harris 54942, Hinds 5333, Ladd 30242, Lay 08-0140, Lendemer 14557, 14308-A, 14338, McMullin 2900, 2921, 2940, 2986, Wetmore 97620, 97669, 97679, 97797.* Localities 1, 2, 3, 4, 7. On trees, especially *Thuja.*

Pycnora sorophora (Vainio) Hafellner – *Bennett 49, Buck 54246, 56609, Harris 56546.* Localities 1, 8, 12. On *Pinus banksiana* and stump on beach. A common lichen in northern Europe, this small squamulose lichen was well known from the southwestern United States (Timdal 2002, sub *Hypocenomyce pycnora*). This is the first published record for Ontario, but it was reported from British Columbia, Manitoba and Nunavut by Spribille and Björk (2008), who also present records from Alaska and elsewhere in western U.S.A. It is also listed for New Brunswick by Clayden (unpublished) and is found in Genesee County in New York (*Battaglia 2010-010*, Bergen Swamp Preserve [NY]) in eastern North America.

Pyrenula pseudobufonia (Rehm) R.C. Harris – *Freebury 694, Lendemer 14485.* Locality 7. On *Acer saccharum.*

Pyxine sorediata (Ach.) Mont. – *Dibble 17057, Hinds 5325, 5328, Lewis 273.* Locality 2. On *Acer saccharum* bark.

Ramalina intermedia (Delise *ex* Nyl.) Nyl. – *Bennett 50, Brodo 32247, Burke s.n., Buck 54207, Dibble 17123, Harris 54940, Lay 08-0141, 08-0142, 08-0143, Lendemer 14474, 14588-A, 14313, 14502, Lewis 247, McMullin 2922, 2987, Wetmore 97687, 97760.* Localities 3, 4, 6, 7. On trees, wood and rocks.

Ramalina obtusata (Arn.) Bitter –*Lendemer 14457, Lewis 275.* Localities 6, 7. On limestone.

Ramalina pollinaria (Westr.) Ach. – *Lendemer 14495, Lewis 246, Wetmore 97759, Ladd 30329.* Locality 7. On limestone and base of old *Thuja.*

**Refractohilum peltigerae* (Keissler) D. Hawksw. – *Harris 55000.* Locality 7. On *Peltigera evansiana.*

Rhizocarpon grande (Flörke *ex* Flotow) Arnold – *Brodo 32314, Guccion 1319, Lay 08-0265, Lendemer 14450, Lewis 305.* Locality 6. On siliceous glacial erratics on alvar.

Rhizocarpon reductum Th. Fr. – *Bennett 51, Lay 08-0263, Lendemer 14440-C, 14365.* Localities 6, 7, 8. On granite boulders and stones.

Rhizocarpon lavatum (Fr.) Hazsl. – *Harris 56547.* Locality 12. On granite boulder.

Rhizocarpon reductum Th. Fr. – *Lay 08-0263, Lendemer 14365, 14440-C.* Localities 6, 7, 8. On glacial erratics.

Rhizoplaca subdiscrepans (Nyl.) R. Sant. – *Harris 56548.* Locality 12. On glacial erratic.

Rinodina bischoffii (Hepp) A. Massal. – *Brodo 32282, 32331, Hinds 5367.* Localities 1, 7. On limestone boulders.

Rinodina efflorescens Malme – *Lendemer 14311.* Locality 3. On *Acer.*

Rinodina freyi H. Magn. – *Harris 56580-C, Lay 08-0280, Lendemer 14306-A.* Localities 2, 3, 7. On *Acer,* dead *Populus, and Thuja.*

Ropalospora viridis (Tønsberg) Tønsberg – *Harris 54877, 56504, 56505.* Localities 1, 13. On slanting, dead *Picea*, and on *Populus* and *Quercus.* This species is common in northeastern North America and was recently revised and illustrated by Lendemer (2011). It is also listed for British Columbia (Qian & Klinka 1998).

Sagiolechia protuberans (Ach.) A. Massal. – *Lewis 308.* Locality 11. On limestone. This is another arctic distjunct known previously in Canada only from Yukon Territory, Northwest Territories and Nunavut (Thomson 1997). See also comments herein for *Lecidea atrobrunnea.*

Sarcogyne regularis Körber – *Bennett 52, Brodo 32274, 32308, 32357, Burke s.n., Freebury 655, 691, Guccion 1280, 1344, Hinds 5315, 5332, Ladd 30295, Lay 08-0144, 08-0145, Lendemer 14537, 14177, 14126-A, 14296, Lewis 288, McMullin 2988, Wetmore 97590.* Localities 1, 2, 4, 6, 7. On dolomite and limestone.

†*Sarea difformis* (Fr.) Fr. – *Lendemer 14499-A*. Locality 7. On *Picea sap.* This is the first report of *Sarea difformis* from Ontario. There are specimens in NY from Nova Scotia, Pennsylvania and Vermont, and there is also an unpublished record from New Brunswick (Clayden, personal communication). The species was reported from Canada (British Columbia and Saskatchewan) by Hawksworth and Sherwood (1981). It is a much rarer fungus than *S. resinae*, also found in the park.

†*Sarea resinae* (Fr.) Kuntze – *Lendemer 14136-A*. Localities 1, 2, 7. On *Picea* and *Pinus* resin.

Scoliciosporum chlorococcum (Stenh.) Vězda – *Buck 54322, Guccion 1311, 1312, Lay 08-0037, 08-0146, 08-0147, Lendemer 14136, McMullin 2948.* Localities 1, 2, 5, 6, 7, 8. On conifer cones and wood.

Scoliciosporum umbrinum (Ach.) Arnold – *Guccion 1295, Lee s.n.* Localities 2, 7. On dead *Thuja* twig and on trunk of *Fraxinus americana*. This species normally grows on rock.

Solorina saccata (L.) Ach. – *Bennett 53, Buck 54136, 54136, Lay 08-0148, Lendemer 14149, 14525, Lewis 262, McMullin 2906, Wetmore 97597.* Localities 1, 2, 7. On moss over soil.

**Sphinctrina anglica* Nyl. – *Lay 08-0149, Lendemer 14269, 14414, 14326, McMullin 2923.* Localities 2, 3, 4, 6. On *Protoparmelia hypotremella* on lignum. Brodo and Aptroot (2005) recently reported on the distribution of this species and its host in North America.

**Spirographa fusisporella* (Nyl.) Zahlbr. – *Harris 54947-A*. Locality 3. On *Ochrolechia arborea*.

Staurothele drummondii (Tuck.) Tuck. – *Brodo 32276, Harris 55012, Hinds 5355, 5359, 5360, Ladd 30378, Lay 08-0150, Lendemer 14567, 14152, Wetmore 97607, 97773.* Localities 1, 7. On limestone boulders, beach cobbles, and low rock faces near the lake shore.

†*Stenocybe major* (Nyl.) Körber – *Lewis 231, McMullin 2941, 2949.* Localities 1, 2, 8. On *Abies balsamea* bark.

Stereocaulon glaucescens Tuck. – *Buck 56585, Harris 56550-A, 56549, 56551, 56552.* Locality 12. On glacial erratic.

Stereocaulon saxatile H. Magn. – *Lendemer 14413, 14398, 14391.* Localities 6, 8. On glacial erratics.

†***Stictis radiata*** **(L.) Pers.** – *Buck 54310, Dibble 17100.* Localities 1, 7. On rotting wood of *Thuja occidentalis*, and on trunk of *Populus*. First record for Canada.

**Stigmidium* sp. – *Buck 54278, Harris 54922-A*. Localities 2, 6. On *Bacidia coprodes*. First record for Canada.

Strigula stigmatella (Ach.) R.C. Harris – *Buck 56475, Lendemer 14149-A, 14132, 14337-A, Wetmore 97578.* Localities 1, 3. At bases of *Thuja* and on humus.

Thelidium decipiens (Nyl.) Kremp. – *Harris 54952*. Locality 4. On dolomite at edge of lake.

Thelidium minutulum **Körber** – *Lay 08-0272*. Locality 7. On calcareous rock. This seems to be a first published report for Canada, although there are specimens from Haida Gwaii, British Columbia and Baffin Island, Nunavut in CANL. It is also recorded from the Ozarks, Louisiana and Pennsylvania (CNALH 2011). This odd distribution deserves checking.

Thelocarpon epibolum Nyl.var. *epithallinum* (Leighton *ex* Nyl.) G. Salisb. – *Lewis 298, 238*. Localities 1, 7. On algae over moss, and on rotting wood covered with cyanobacteria. This species is normally a parasite on cyanolichens, especially *Peltigera*. In CANL, there is a specimen from Grand Falls District of Newfoundland and Labrador (*Ahti 8118a*), and it is listed for British Columbia by Qian and Klinka (1998).

Thelocarpon superellum Nyl. – *Harris 54959*. Locality 8. On soil.

Toninia sedifolia (Scop.) Timdal – *Brodo 32313, Buck 54264, Dibble 17211, Freebury 683, Harris 54993, Lay 08-0152, 08-0153, Lendemer 14448, 14435, 14147, 14529, Wetmore 97729, 97738.* Localities 1, 6, 7. On soil and moss over limestone.

Trapelia placodioides Coppins & P. James – *Brodo 32335, Harris 54915, Lay 08-0154, Lendemer 14480, 14554, 14309-A, 14360, McMullin 2989.* Localities 2, 3, 4, 6, 7. On small stones and erratics.

Trapeliopsis flexuosa (Fr.) Coppins & P. James – *Bennett 55, Brodo 32252, Harris 54894, Lendemer 14451, 14442, Wetmore 97676.* Localities 1, 3, 5, 6. On lignum.

Trapeliopsis granulosa (Hoffm.) Lumbsch – *Ladd 30305, Lendemer 14433, 14378, 14518-A, Olszewski 6756.* Localities 2, 6, 7, 8. On humus.

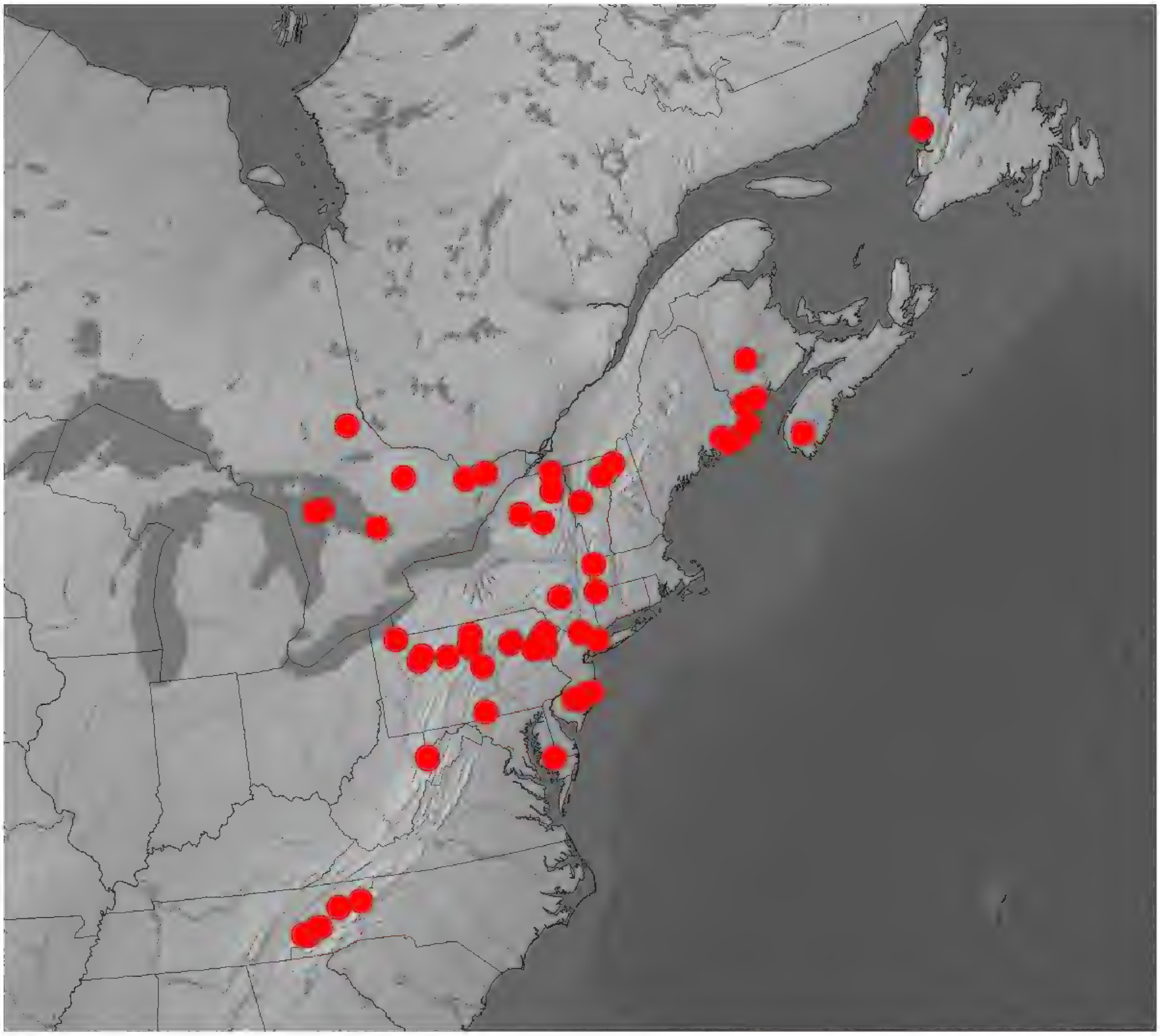

Figure 6, eastern North American distribution of *Violella fucata* based on specimens in NY and CANL.

Trapeliopsis pseudogranulosa Coppins & P. James – *Beeching 6779*. Locality 7. On spruce bark. The type of this suboceanic lichen is from British Columbia (Coppins & James 1984) and it occurs elsewhere in the Pacific Northwest. Until now, the species was unknown in Canada outside of British Columbia, making the Ontario record a remarkable disjunction. However, there is also a specimen from Acadia National Park, Maine (*Wetmore 46254,* MIN).

Trapeliopsis viridescens (Schrader) Coppins & P. James – *Wetmore 97580, 97647, 97800.* Localities 1, 2, 7. On base of *Acer saccharum*.

****Tremella candelariellae* Diederich & Etayo** – *Harris 54939*. Locality 3. On *Candelariella efflorescens*.

Tuckermannopsis americana (Sprengel) Hale –*Buck 54269, Harris 54979, Hinds 5340, 5341, 5346, 5348, Lay 08-0155, Lendemer 14464, 14461, 14364, Wetmore 97628, 97708.* Localities 1, 5, 6, 8. On *Pinus banksiana*.

Tuckermannopsis sepincola (Ehrh.) Hale – *Dibble 17186, Hinds 5350, Ladd 30315, Lay 08-0156, Lendemer 14181-A*. Localities 1, 5, 6. On conifer twigs.

Umbilicaria mammulata (Ach.) Tuck. – *Buck 56597, Harris 56555*. Locality 12. On glacial erratic.

Usnea filipendula Stirton –*Harris 55020, Lendemer 14403-A, Wetmore 97787.* Localities 6, 7. On fallen balsam fir.

Usnea hirta (L.) F.H. Wigg. – *Guccion 1298, 1313, 1332, Lendemer 14516, Wetmore 97651, 97702.* Localities 2, 3, 5, 7. On hardwoods and conifers.

Usnea lapponica Vainio – *McMullin 2990*. Locality 7. On conifer snag.

Usnea subfloridana Stirton – *Lay 08-0157, Lendemer 14353, 14403, 14514, 14509, 14505.* Localities 4, 6, 7. On branches and twigs.

Usnocetraria oakesiana (Tuck.) M.J. Lai & J.C. Wei – *Bennett 07, Brodo 32336, Burke s.n., Freebury 693, Guccion 1320, Hinds 5363, Ladd 30333, Lay 08-0043, Lendemer 14558, Lewis 263, McMullin 2967.* Locality 7. On *Betula, Populus* and *Thuja.*

Varicellaria velata (Turner) Schmitt & Lumbsch [syn. *Pertusaria velata* (Turner) Nyl.] – *Brodo 32248, Wetmore 97680.* Locality 3. On dead trunk of *Fraxinus* at edge of swamp.

Variolaria amara Ach. [syn. *Pertusaria amara* (Ach.) Nyl.] – *Brodo 32249, Buck 54215, Guccion 1297, Ladd 30179, 30270, 30294, Lay 08-0121, Lendemer 14589, 14142, 14284, 14327, McMullin 2896, 2919, 2984, Olszewski 6752, Wetmore 97584, 97673, 97803.* Localities 1, 2, 3, 6, 7. On *Thuja* and deciduous trees.

Verrucaria calkinsiana Servit – *Brodo 32259, 32275, Buck 54132, 54132, Guccion 1281, Lendemer 14286-A, 14286, 14369.* Localities 1, 2, 8. On limestone.

Verrucaria glaucovirens Grummann – *Wetmore 97750, 97577, 97606.* Localities 6, 7. On limestone boulders.

Verrucaria muralis Ach. – *Harris 56484, Lay 08-0158, Lendemer 14193, 14551, 14258, Wetmore 97587, 97603.* Localities 1, 2, 7, 8. On dolomite.

Verrucaria nigrescens Pers. – *Brodo 32310.* Locality 6. On limestone.

Vezdaea acicularis Coppins – *Buck 54227, Lee 2412.* Locality 4. On upturned soil at base of fallen tree. Although this is a first record for Ontario, it was reported from the Québec side of the Ottawa region by Brodo (2001). There is also a specimen from Putnam County, New York but it appears to be much rarer than *V. leprosa*, also found in the park, which is frequently recorded from eastern North America and the Ozarks (NYBG 2011).

Vezdaea leprosa (P. James) Vězda – *Buck 54131, Lendemer 14527-A.* Localities 1, 7. On humus. This species was reported from the Ottawa region by Brodo (2001).

Violella fucata (Stirton) T. Sprib. [syn. *Mycoblastus fucatus* (Stirton) Zahlbr.] – *Harris 56515, Lendemer 14215, 14361, 14479, 14428, 14203, 14262, 14259-A, 14345.* Localities 1, 2, 4, 6, 8. On *Acer, Fraxinus, Thuja* and *Picea.* There is a specimen from British Columbia (Pemberton area) in CANL and it is listed for New Brunswick and Nova Scotia (Canadian checklist, unpubl.). This species appears to be very common in the Appalachian Mountains and northern boreal forests of eastern North America based on the available material at NY and CANL (Fig. 6) (NYBG 2011).

Vulpicida pinastri (Scop.) J.-E. Mattsson & M.J. Lai – *Hinds 5350, Lay 08-0159, Wetmore 97792.* Localities 5, 7. On *Pinus banksiana.*

Xanthoparmelia cumberlandia (Gyelnik) Hale – *Harris 54960, 56556, 56557, Hinds 5336, Lendemer 14446, 14395.* Localities 6, 8, 12. On glacial erratic.

Xanthoparmelia plittii (Gyelnik) Hale – *Bennett 58.* Locality 6. On rock.

Xanthoria elegans (Link) Th. Fr. – *Bennett 59, Buck 54262, Burke s.n., Dibble 17076, Guccion 1282, Harris 55005, Hinds 5312, 5359, 5360, Ladd 30231, 30365, Lay 08-0160, Lendemer 14564, 14549, 14148, 14122, McMullin 2908.* Localities 1, 6, 7. On limestone.

Xanthoria sorediata (Vainio) Poelt – *Guccion 1283, Ladd 30349, Lewis 259, Lendemer 14195, 14175, Wetmore 97767.* Localities 1, 7. On dolomite and limestone.

Xylographa vitiligo (Ach.) J.R. Laundon – *Beeching 6723.* Locality 1. On *Thuja.* The species is known in Canada from Newfoundland (NYBG 2011), British Columbia, Alberta, Québec, New Brunswick and Nova Scotia (Canadian checklist, unpubl.).

Species from Bruce County, not found on Workshop (Wong & Brodo 1992, except for entries with an asterisk (*)).

Cladonia gracilis (L.) Willd. ssp. *turbinata* (Ach.) Ahti

Cladonia rei Schaerer

**Eiglera flavida* (Hepp) Hafellner (F. Schueler, May 1984; det. P.Y. Wong & I.M. Brodo [CANL]) This is another remarkably disjunct arctic species, like *Hymenelia heteromorpha*, which it resembles except for the distinctly K/I+ blue reaction in the ascus tips.

**Fulgensia bracteata* (Hoffm.) Räsänen subsp. *bracteata* (*C. Schaefer CAS1812* [CANL], det. C. Lewis, C. Freebury and I. Brodo) Manitoulin Island, Misery Bay, over soil and moss in exposed site. The name *Fulgensia bracteata* has been used in a very broad sense in many publications and so its true distribution in North America needs to be reevaluated.

Megalaria laureri (Th. Fr.) Hafellner
Peltigera ponojensis Gyelnik
Pertusaria alpina Hepp ex Ahles
Phaeocalicium curtisii (Tuck.) Tibell
Polyblastia cfr. obsoleta Arnold
Ramalina dilacerata (Hoffm.) Hoffm.
Rinodina degeliana Coppins
Rinodina subminuta H. Magn.
**Stereocaulon tomentosum* Th. Fr. (*Puckett & Richardson no. 1,* Manatoulin Island [CANL])
Thermutis velutina (Ach.) Flotow
Tuckermannopsis orbata (Nyl.) M.J. Lai
Verrucaria nigrescentoidea Fink This includes specimens originally identified and reported as *V. fuscella* (Turner) Winch (= *Placopyrenium fuscellum* (Turner) Gueidan and Cl. Roux (Navarro-Rosinés et al. 2007)).
**Xanthoria parietina* (L.) Th. Fr. (Brodo et al. 2007)

Additional Species reported from Bruce Alvar Nature Reserve (Nature Ontario tract) not found on Workshop or elsewhere in Bruce County. (These are unverified reports.)

(John Gerrath, Guelph University, ON., 31 Dec. 2006)
Cladonia parasitica (Hoffm.) Hoffm.
Cladonia symphycarpa (Flörke) Fr.
Rhizocarpon lecanorinum Anders
Thelidium cfr. absconticum (Hepp) Rabenh.

DISCUSSION

Eastern alvars often show relationships with the vascular plant flora from western grasslands (Catling 1995, Catling & Brownell 1995), and the Bruce alvars are no exception with respect to lichens. Examples of this relationship include species of *Acarospora, Biatorella, Placidium, Heppia,* and *Psora. Fulgensia bracteata*, found on Manitoulin Island just to the west, should be sought on the Bruce Peninsula alvars. These disjuncts may well have had their origins as part of the peri-glacial plant community that existed along the ice front approximately 9000 years ago (Catling & Brownell 1995).

Astonishing disjunctions from the far north were also seen, most of them growing on limestone, e.g., *Eiglera flavida, Farnoldia hypocrita* and *Hymenelia heteromorpha. Lecidea atrobrunnea*, an arctic species, was growing on granitic erratic boulders lying on the exposed alvar.

Many of the lichen discoveries new for Canada (92%) and Ontario (31%) were limestone-dwelling species, some of them fairly common and widespread, especially in the east. They probably appear to be rare in Canada simply because this substrate is not as common as siliceous rock (e.g., on the pre-Cambrian shield) and is therefore relatively understudied. Examples are *Bagliettoa baldensis, Botryolepraria lesdainii, Caloplaca subsoluta, Epigloea pleiospora* and *Psorotichia schaereri.*

The occurrence of coastal or oceanic species such as *Biatora ocelliformis, Cliostomum leprosum, Enterographa zonata*, *Pseudosagedia aenea* and *Trapeliopsis pseudogranulosa,* were undoubtedly responding to the constantly humid conditions in the talus formations, cliffs and crevices along the lake shore.

The disjunctions from the southwest are harder to understand, although a few have arctic or central prairie connections, e.g., *Diplotomma venustum, Fulgensia bracteata* and *Heteroplacidium compactum*.

CONCLUSIONS

HOT SPOTS OF DIVERSITY IN BRUCE PENINSULA NATIONAL PARKS

Lichen diversity, including numbers of rare species, was greatest on the shore and bluffs near Halfway Log Dump. This locality was only a sample of that habitat, which runs along almost the entire length of Bruce Peninsula National Park along Georgian Bay. That part of the park, therefore, deserves most scrutiny and protection from disturbance. The Halfway Log Dump site and corridor has special value itself because of the proximity of several other habitats of high lichen diversity: the old maple forest, the swamp edge, and the Bartley Lake area.

Flowerpot Island was the second most lichenologically diverse locality, with its many and varied habitats and microhabitats due to its shaded and exposed rock formations, wind- and fog-swept landscape and unique forest type. Of the 196 lichens found there, about 30 can be considered to be rare. Being isolated and off-shore, it is most remote and yet most vulnerable to impact by its thousands of visitors as trails criss-cross the island providing relatively easy access to most areas. The lichens of the island, however, seem to be oblivious to all but direct attacks (by lichen collectors, for example, and by being trampled). There is no nearby source of air pollution (sulphur dioxide) to threaten the lichens, which are notoriously sensitive to poor air quality (Henderson 2000, Richardson 1992). It would seem that simply encouraging visitors to stay on trails would protect the many rare lichens on the island.

The alvars are also rich in species, including rarities. These areas are more sensitive to disturbance because of their thin, vulnerable soils and take a long time to recover (Gerrath 2006). With the alvar lichen flora now relatively well documented, the time is ripe for an in-depth study of the relationships of various lichens to specific types of Great Lakes alvars and microhabitats within the alvars, as described by Catling and Brownell (1995).

The sand dune area (Singing Sands) with its spruce-pine forest had a number of species found nowhere else in the park and deserves special attention. This was especially true of the lichenicolous fungi. Lichens growing on sand are very easily disturbed (Brodo 1968: 28).

RARE AND NEW RECORDS

The Tuckerman Workshop survey not only created an inventory of the lichens of the two Bruce Peninsula national parks, but also made a significant contribution to our knowledge of the lichens of North America, Canada and Ontario.

Of the 21 new records for Canada, 12 are lichens, 8 are parasites and one is a related fungus; almost all of the lichens were growing on calcareous rock. Calcareous rock substrates are therefore worthy of much greater study in Canada.

In addition to the species new for North America and Canada, there were 35 new lichen records for Ontario, as well as 12 new parasites and two related fungi. Lichen parasites have been largely overlooked in North America, so it is not surprising that a large percentage of the new records for Canada (38%) and Ontario (24%) are in this category. The number of new records, and the observation that they include species on a variety of substrates, shows that Ontario still needs much more study before the full diversity of lichens is known.

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APPENDIX A – TUCKERMAN WORKSHOP PARTICIPANTS

Virginia Amundson (Chisago City, MN), Sean Beeching (Atlanta, Georgia), Jim Bennett (University of Wisconsin, Madison, WI), Andrea Borkenhagen (Calgary, AB), Irwin Brodo, (Canadian Museum of Nature, Ottawa, ON) , William Buck (New York Botanical Garden, Bronx, NY), En Burk (Toronto, ON), Steve & Barbara Clayden (New Brunswick Museum, Saint John, NB), Heather Coffey (Montreal, QC), Allison & Keith Dibble (Brooklyn, ME), Jennifer Doubt (Canadian Museum of Nature, Ottawa, ON), Diane Fahselt (University of Western Ontario, London, ON), Colin Freebury (Ottawa, ON), Susan Gibson (Ottawa, ON), John Guccion (Bethesda, MD), Richard Harris (New York Botanical Garden, Bronx, NY), Jim & Pat Hinds (Orono, ME), Malcolm Hodges (The Nature Conservancy, Atlanta, GA), Joe Johnson (Wiarton, ON), Elisabeth Kneiper (Weston, MA), Doug Ladd (The Nature Conservancy, St. Louis, MO), Elisabeth & Michael Lay (Boston, MA), Rob Lee (White Lake, ON), James Lendemer (New York Botanical Garden, Bronx, NY), Chris Lewis (Lindsay, ON), Sophie Mazowita (Whitney, ON), Troy McMullin (University of Guelph, Guelph, ON), Roman Olszewski (Welland, ON), Michael Richardson (Brighton, ON), Ryne Rutherford (Marquette, MI), Juan Sanchez (Chaplin, CT), Hal Schaefer (Dorchester, MA), Cliff Wetmore, & Chin Ping Yang (University of Minnesota, St Paul).

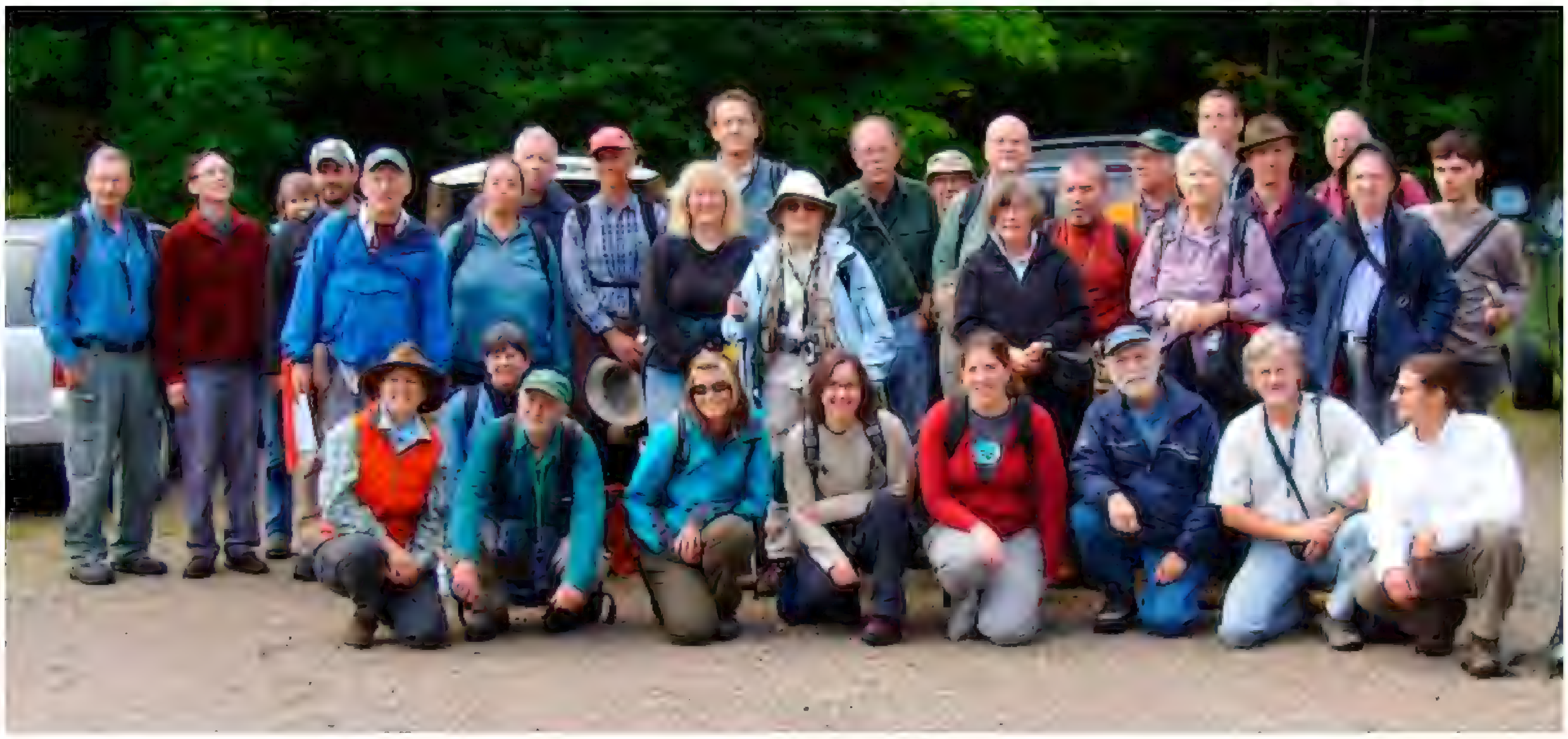

Figure 7, Participants in 2008 Tuckerman Workshop. *Standing, left to right*: Juan Sanchez, Rob Lee, Jennifer Doubt, Chris Lewis, Jim Bennett, En Burk, Joe Johnson, Colin Freebury, Virginia Amundson, Stephen Clayden, Pat Hinds, Richard Harris, Cliff Wetmore, Bill Buck, Elizabeth Kneiper, Malcolm Hodges, Doug Ladd, Elisabeth Lay, Troy McMullin, Sean Beeching, Hal Schaefer, John Guccion, James Lendemer. *Kneeling, left to right:* Allison Dibble, Diane Fahselt, Jim Hinds, Andrea Borkenhagen, Heather Coffey, Sophie Mazowita, Irwin Brodo, Roman Olszewski, Ryne Rutherford. *Missing from photo:* Susan Gibson, Michael Richardson, Chin Ping Yang. Photo by Troy McMullin.

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A new lichenicolous *Enterographa* (Arthoniales, Roccellaceae) from central North America

CALEB A. MORSE[1]

ABSTRACT. – *Enterographa osagensis*, a lichenicolous fungus associated with the thallus of *Bacidina* species, is described as new to science. The species is characterized by its lichenicolous habit, punctiform to ellipsoid, non-pseudostromatic ascomata, 0.08–0.16 × 0.07–0.15 mm, and 3-septate, halonate ascospores ca 12.3–14.9 × 3.6–4.3 µm. It is documented from Kansas, Missouri, and Oklahoma in the central United States.

KEYWORDS. – Great Plains, Ozarks.

INTRODUCTION

The genus *Enterographa* Fée was circumscribed by Sparrius (2004) to include 35 species of foliicolous, corticolous, saxicolous, and lichenicolous Roccellaceae with immersed, punctiform to lirelliform, often pseudostromatic ascomata, non-carbonized, hyaline or pale brown exciple and hypothecium, and hyaline, halonate, 3 to many-septate spores. Subsequent publications (Aptroot et al. 2007; Cáceres 2007; Ertz 2009a, 2009b; Ertz et al. 2005; Gao et al. 2009; Jagadeesh Ram et al. 2008; Seaward & Aptroot 2009; Sparrius & Aptroot 2007; Sparrius & Björk 2008; Sparrius et al. 2006; Yeshitela et al. 2009) added 15 species to *Enterographa*, bringing the number of species to 50 worldwide. The genus as circumscribed by Sparrius (2004) demonstrates a largely tropical pattern of distribution, with only a small number of species known from temperate Europe and North America (Sparrius 2004, Sparrius & Aptroot 2007, Sparrius & Björk 2008). Six species have been reported from North America (Esslinger 2012, Sparrius 2004, Tønsberg & Brodo 1992).

Recent phylogenetic studies have suggested *Enterographa* as circumscribed by Sparrius (2004) is non-monophyletic (Ertz et al. 2009, Ertz & Tehler 2011). To date, however, only a small number of species have been sequenced and morphological correlates of the molecular data are few and somewhat uncertain. Further, no molecular studies have included lichenicolous species, and the disposition of these members of the genus remains unresolved. During recent fieldwork along the eastern edge of the Great Plains in Kansas and Missouri, and in southwest Oklahoma, the author and collaborators collected an unusual taxon associated with members of the genus *Bacidina* Vězda. The new species fits the concept of the genus presented by Sparrius (2004) and is described here as *Enterographa osagensis.*

MATERIAL AND METHODS

Specimens were studied dry using dissecting microscopes and subjected to chemical analysis using standard spot tests (reagents are abbreviated following Brodo et al. (2001)) and Thin Layer Chromatography (TLC). TLC was carried out at KANU using solvent systems A, B′ and C following the methods of Orange et al. (2001). Microscopic characters were observed in water and images were captured and measured to the nearest hundredth µm using a Lumenera Infinity X-32 soft imaging system camera with Infinity Analyze 6.2.0. Measurements are presented as a simple range or, where sufficient material allowed, as the average ($\bar{x}$) +/- one standard deviation (SD), bounded by the smallest and largest observed

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[1] CALEB A. MORSE – Biodiversity Institute, R. L. McGregor Herbarium, University of Kansas, 2045 Constant Ave., Lawrence, KS 66047, U.S.A. – e-mail: cmorse@ku.edu

values, and followed by the sample size (n) (i.e., (smallest observed) $\bar{x}$-1SD – $\bar{x}$ – $\bar{x}$+1SD (largest observed) [n=]).

TAXONOMIC SECTION

Enterographa osagensis **C.A. Morse sp. nov.**
Mycobank #805811.

TYPE: U.S.A. KANSAS. DOUGLAS CO.: 1.5 mi N, 1.5 mi E of jct of US Hwy 56 & DG Co Rd 1055 in Baldwin City, NE side of Douglas County State Lake, above dam, 38.80506°N, 95.15511°W, elev. ca 1010 ft., disturbed, open, secondary forest at top of steep, W-facing slope above dam, occasional calcareous sandstone and finely crystalline limestone outcrops near top of slope, 23.iv.2011, on *Bacidina egenula* on limestone, *C.A. Morse 22329 & K. Logan* (KANU-387075!, holotype; BR!, hb. Ladd!, KANU!, NY!, isotypes).

DIAGNOSIS. — Lichenciolous *Enterographa* producing punctiform, discoid, or ellipsoid ascomata (0.05) 0.08–0.16 (0.23) × (0.05) 0.07–0.15 (0.23) mm, growing on the thallus of *Bacidina* species; disks greyish yellow, reddish brown, blackish brown, or black, with white margins; asci clavate, 8-spored, (24.2) 30.5–42.0 (49.7) × (8.8) 10.1–14.3 (19.5) µm; ascospores (2) 3-septate,(10.7) 12.3–14.9 (17.5) × (3.1) 3.6–4.3 (5.0) µm.

FIGURE 1.

DESCRIPTION. – Independent thallus absent, lichenicolous on the thallus of *Bacidina* spp.; vegetative hyphae not observed. Ascomata mostly dispersed, occasionally in groups of 2 to 4 or more (not in a stroma); initially immersed in thallus, soon sessile, open, punctiform to discoid, occasionally ellipsoid, comma-shaped or irregular, (0.05) 0.08–*0.12*–0.16 (0.23) × (0.05) 0.07–*0.11*–0.15 (0.23) mm in diameter [n=30]; disks greyish yellow, reddish brown, blackish brown, or black, often initially pruinose, eventually epruinose; outer margins white, thick initially, thinning with age and occasionally separating from the exciple, (0.2)0.04–*0.07*–0.1(0.13) mm wide [n=30], lacking a photobiont, with dense aggregations of calcium oxalate (POL+) crystals, these irregular to +/- rectilinear, to 7 µm wide, but mostly much smaller, dissolving in H_2SO_4. Epithecium and upper hymenium pale brown, K-; hymenium hyaline, ca. 55 µm high, not inspersed with oil droplets; paraphysoids richly branched and anastomosed, rather stout, 1.4–*1.8*–2.1 µm towards distal end, but scarcely expanded at apex; excipulum very thin, ca. 5–15 µm wide, upper part pale brown, K-, C- in section; hypothecium hyaline, K-, ca. 17 µm high, not extended below. Asci *Opegrapha*-type, KI- except for an apical KI+ blue ring, broadly clavate, (24.2) 30.5–*36.2*–42.0 (49.7) × (8.8) 10.1–*12.2*–14.3 (19.5) µm [n=49, measured at various points in development], 8-spored; ascospores hyaline, thin-walled, (2) 3-septate with septation beginning with one median septum, ±fusiform to clavate (with subdistal or distal and subdistal cells slightly broader than the proximal cells), sometimes slightly curved, occasionally constricted at the septa (mostly easily observed in submature ascospores in ascus), cells as long as wide, the distal 2 cells occasionally wider than long, or the proximal cell occasionally slightly longer than wide, ends acute or distal end sometimes rounded, (10.7) 12.3–*13.6*–14.9 (17.5) × (3.1) 3.6–*3.9*–4.3 (5.0) µm (excluding perispore), l/b ratio (2.6) 3.1–*3.5*–3.9 (4.5) [n=149], perispore indistinct (observed about half the time) or to 1.3 µm wide. Conidiomata not observed.

CHEMISTRY. – Ascomata K-, C-, PD-; margins and disks UV-. No substances were detected by TLC.

ETYMOLOGY. — The new species is named for the Osage Plains ecoregion, where it was first collected.

DISTRIBUTION AND ECOLOGY. – *Enterographa osagensis* is presently known from material referred here to *Bacidina delicata* (Leight.) V. Wirth & Vězda, *B. egenula* (Nyl.) Vězda, and a corticolous species identified only to genus. North American specimens of *B. delicata* may differ somewhat from European material (Harris & Lendemer 2005), and the identity of our specimens remains to be confirmed.

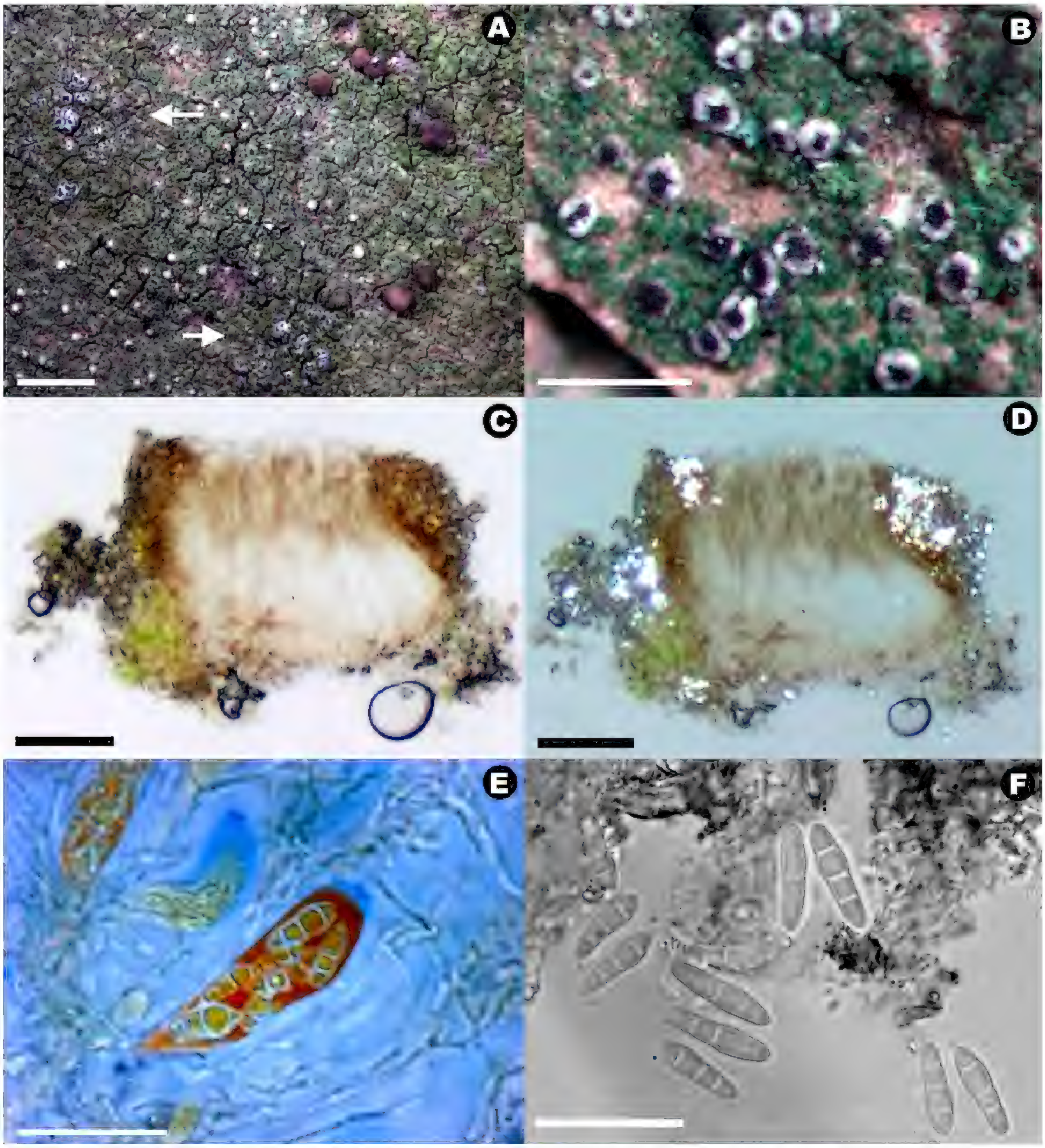

Figure 1. *Enterographa osagensis*. A, habit with ascomata (right side of image) and pycnidia (central and lower left part of image) of host (arrows point to areas of infection by *E. osagensis*; *Morse 22329* [isotype], KANU); B, habit (*Morse 20459,* KANU); C, ascoma (*Morse 22329,* KANU; 200×); D, ascoma in polarized light (*Morse 22329,* KANU; 200×); E, asci after treatment with KI + ZnIKI (*Morse 21507*, KANU; 1000×); F, spores (*Morse 21507*, KANU; 1000×). Scale bars A and B = 0.5 mm; C and D = 50 µm; E and F = 20 µm.

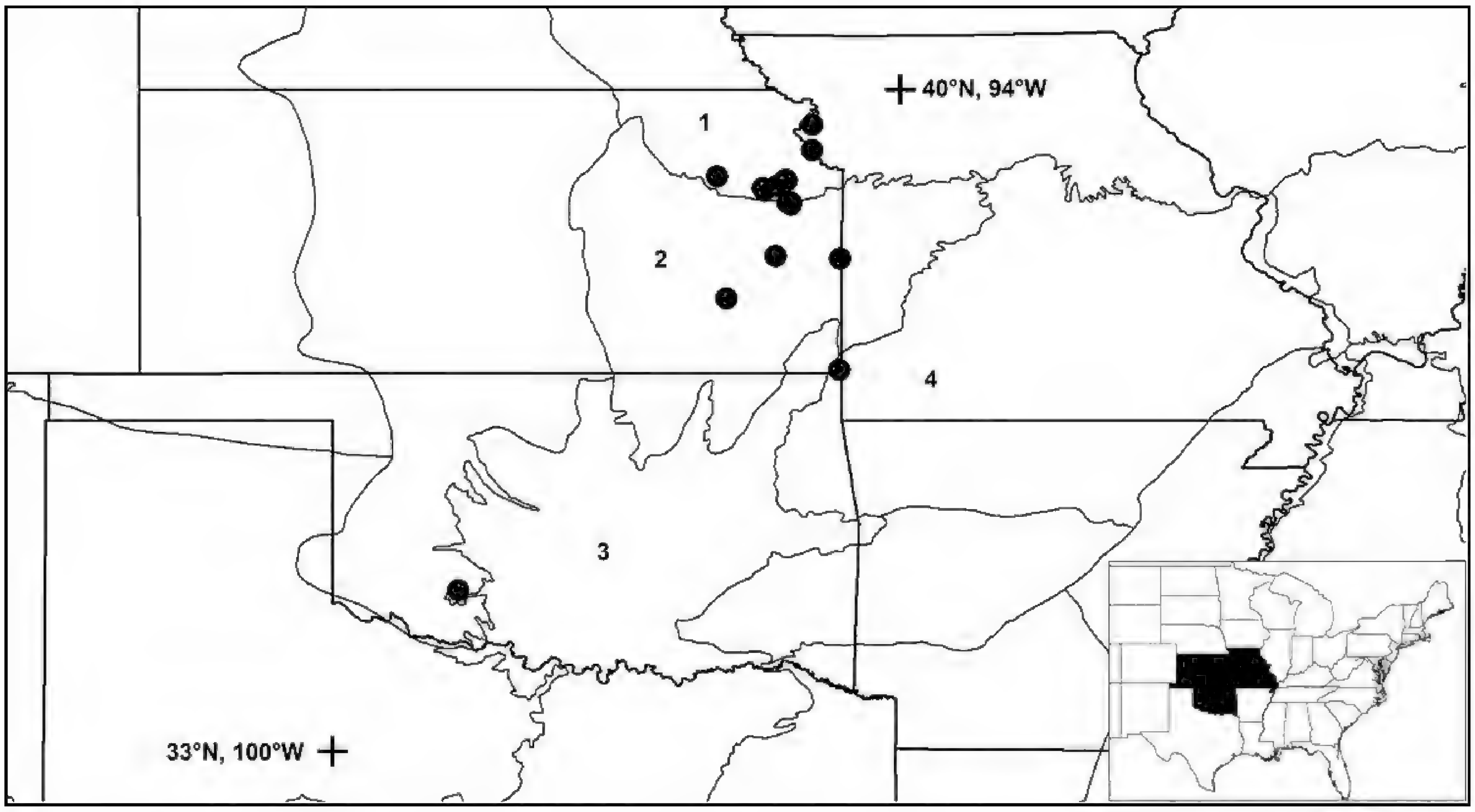

Figure 2. Known distribution of *Enterographa osagensis*. Numbers indicate TNC Ecoregions: 1 = Central Tallgrass Prairie; 2 = Osage Plains/Flint Hills Prairie; 3 = Crosstimbers and Southern Tallgrass Prairie; 4 = Ozarks (The Nature Conservancy 2007).

However, material referred here to *B. delicata* comports well with descriptions of the reproductive structures found in European floras (*e.g.*, Coppins & Aptroot 2009, treated as a species of *Bacidia* De Not.). The new species has been found occurring on hosts in lightly shaded, upland sites, in mixed oak-hickory hardwood forests and transition zones between forest and tallgrass prairie, between 780–1070 ft (237–326 m) elevation in the Central Tallgrass Prairie, Osage Plains/Flint Hills Prairie, Crosstimbers and Southern Tallgrass Prairie, and Ozarks ecoregions in eastern Kansas, northwest Missouri and central Oklahoma (The Nature Conservancy 2007; Fig. 2). In this region, typical substrates of *B. delicata* include pebbles of polished chert, non-calcareous sandstone, Sioux quartzite, or other unidentified, non-calcareous rock; and weathered ("rotten") chert residuum. Several specimens, including the type, have been found associated with *B. egenula* on boulders and outcrops of calcareous sandstone and finely crystalline limestone. More rarely, *E. osagensis* has been collected with its hosts from lignum (*Morse 16477*, *23859*) and bark (*Morse 20563f*, *23207*, and *24047*). Although the ascomata are more uniformly pruinose and the hypothecium is somewhat deeper in *Morse 20563f*, the specimen matches other collections of *E. osagensis* with respect to ascus size and ascospore characters and the specimen is tentatively included with the new species. This record represents a considerable extension of the distribution of the species to the southwest.

The host species appear to tolerate considerable anthropogenic disturbance; most populations of *Enterographa osagensis* were found to occur in secondary forests with evidence of past logging or other kinds of human activity, and two populations were collected from former gravel mines. *Enterographa osagensis* has not been discovered on suitable substrates in remnant tallgrass prairie, which would have been the dominant plant community on uplands through much of eastern Kansas and western Missouri prior to settlement of the area in the mid-nineteenth century. For this reason, it seems likely that the species reaches the western limit of its distribution along the eastern edge of the Great Plains. Notably, however, *E. osagensis* has not been discovered north of 40°N latitude, from the northeast part of the Great Plains, despite rather rich holdings at KANU of both *B. egenula* and lignicolous material referred to *B. delicata* from eastern Nebraska, South Dakota, and North Dakota, northwest Iowa, and southwest Minnesota. In the Great Plains, the distribution of *E. osagensis* may correspond to the Comanchian floristic subprovince of McLaughlin (2007) and the northern part of the Central Grasslands distribution type of Brodo et al. (2001). In spite of intensive field work in the adjacent Interior Highlands (e.g. Harris & Ladd 2005), where both host species are known, *E. osagensis* appears to be represented by a single collection from the western edge of the Ozark Plateau. However, the ascomata of *E. osagensis* are superficially similar to the pycnidia of its host species, making them easy to overlook, and additional populations may be sought elsewhere in eastern North America.

While the new species appears to be a commensalist for the most part, in a few specimens examined the host thallus is somewhat degraded. While it is unclear that the deterioration is related to the presence of *Enterographa osagensis*, in this case the thallus may not be immediately recognizable as belonging to *Bacidina*. Where ascomata or pycnidia of the host are not evident, the thallus associated with *E. osagensis* is ecorticate, thin, greyish green to dark green, continuous to areolate, often with margins slightly lifted off the substrate, or comprised of goniocysts that are oblong or somewhat irregular in shape, ca. 34–50 × 24–35 µm, with a chlorococcoid photobiont, cells round to ellipsoid or oblong, (7.0) 7.3–*9.5*–11.8 (15.3) µm in the longest dimension.

DISCUSSION. – Six other *Enterographa* species are reportedly lichenicolous. *Enterographa epiphylla* (Sérus.) Ertz et al., *E. fellhaneroides* Yeshitela et al., and *E. meklitiae* Yeshitela et al., all associated with foliicolous *Coenogonium* species, produce 4 or 4–6-spored asci and 4–6-septate ascospores (Ertz et al. 2005, Yeshitela et al. 2009). *Enterographa mazosiae* Matzer & R. Sant., a species known from foliicolous *Mazosia* species, produces 8-spored asci with slightly narrower, 3–4(6) septate ascospores (Sparrius 2004). *Enterographa punctata* Ertz & Diederich, a gall-inducing species on an unidentified *Lobaria* species with a green photobiont, produces 6-spored asci with slightly longer ascospores (Ertz et al. 2005). *Enterographa osagensis* is superficially similar to *E. brezhonega* Sparrius & Aptroot, known from France on the corticolous species *Porina rosei* Sérus. and perhaps *Pachyphiale fagicola* (Hepp) Zwackh. Ascomata of *E. brezhonega* are borne in groups of 2–5 in cerebriform pseudostromata, however, and the asci produce only 4, slightly narrower ascospores, each with (4–)6 septa (Sparrius & Aptroot 2007).

There are eight additional species of *Enterographa* that produce 3-septate ascospores typically ≤ 20 µm long (Aptroot et al. 2007, Seaward & Aptroot 2009, Sparrius 2004). If the lichenicolous habit of *E. osagensis* and the non-trentepohlioid photobiont of its host were overlooked, these would still be found to differ by some combination of thallus or ascoma characters, chemistry, or ecology (Ertz et al. 2005, Seaward & Aptroot 2009, Sparrius 2004). Ascospores of several species of the morphologically similar genus *Sclerophyton sensu* Sparrius (2004) are also 3-septate and ≤ 20 µm long. However, species of that genus differ in having a dark hypothecium, longer asci, or other features (Sparrius 2004).

The outer margin of the ascoma of *Enterographa osagensis* is likely the same structure characterized in other *Enterographa* species with dispersed ascomata as a thalline margin without a photobiont (Sparrius 2004) or as a pseudothalline margin (Sparrius et al. 2006). It may also be the same as the false thalline margin of *Sclerophyton* in Egea and Torrente (1995). Where it has been described in detail, the margin is typically characterized as distinct from the exciple, lacking photobiont cells, and containing calcium oxalate crystals. Although it is beyond the scope of this paper, the development of this margin—and in particular whether or not it is of thalline origin—has some import for the lichenicolous members of *Enterographa*, which have been uniformly characterized as lacking even a reduced thallus. It is perhaps also worth noting that the internal structure of the margin appears to be essentially the same as that of the pseudostromata in other lichenicolous *Enterographa* (Ertz et al 2005, Sparrius & Aptroot 2007, Yeshitela et al. 2009). The conclusion by Ertz et al. (2005) that it is uncertain whether or not pseudostromata of *E. epiphylla* comprise hyphae of the lichenicolous fungus or of the host probably pertains to all of the lichenicolous species, and it is not clear that the definition of Eriksson (1981) may be precisely applied to these structures. Moreover, in some cases, maintaining a distinction between the outer (pseudothalline, or false thalline) margin in species with dispersed ascomata and pseudostroma in species with synascomata (Sparrius 2004) may serve to obscure homologies among closely related taxa.

It is of interest that the new species has been found in association with both *Bacidina egenula* and *B. delicata*. Recent studies have shown *Bacidia s.l.* (including members of *Bacidina*, *Toninia* A. Massal., and other genera) to comprise a heterogeneous assemblage of species groups (Czarnota & Guzow-Krzemińska 2012, Ekman 2001). However, *B. delicata* and *B. egenula* were found to belong to a "core" group of *Bacidina*, which nonetheless may not include the type species, *B. phacodes* (Körber) Vězda. (See discussion in Czarnota & Guzow-Krzemińska 2012.) Commensalists are typically limited in their host selection (Lawrey & Diederich 2003), so the discovery of *E. osagensis* in association with both species may provide corroborating evidence for their close relationship. Conversely, examination of members of *Bacidia s.l.* known from the region, including material referred to *B. bagliettoana* (A. Massal. & De Not.) Jatta, *B. circumspecta* (Nyl. ex Vainio) Malme, *B. coprodes* (Körber) Lettau, *B. diffracta* S. Ekman, *B. rubella* (Hoffm.) A. Massal., *B. schweinitzii* (Fr. ex E. Michener) A. Schneider, *B. suffusa* (Fr.) A.

Schneider, *B. vermifera* (Nyl.) Th. Fr., and *Bacidina assulata* (Körber) S. Ekman, as well as *Arthrosporum populorum* (A. Massal.) A. Massal. and members of *Toninia*, have turned up no admixtures of *E. osagensis.*

Additional specimens examined. – **U.S.A. KANSAS.** ANDERSON CO.: 3.0 mi S, 3.75 mi W of jct of US Hwy 59 & KS Hwy 31 on N side of Garnett, E side of Garnett Cedar Creek Valley Reservoir, 38.24131°N, 95.31953°W, elev. 940–970 ft., 4.xii.2010, on *Bacidina* sp. on chert, *C.A. Morse 22204 & K. Logan* (KANU), on *B. egenula* on limestone, *C.A. Morse 22206a & K. Logan* (KANU). CHEROKEE CO.: ca. 2 mi S of jct of KS Hwy 26 & US Hwy 66/KS Hwy 26 in Galena, Schermerhorn Park, 37.04221°N, 94.63925°W, elev. 880–960 ft., 30.xii.2010, on unidentified host, probably *Bacidina* sp. on chert, *C.A. Morse 22216 & K. Logan* (KANU). DOUGLAS CO.: SE side Lawrence, Lawrence Prairie Park, 38.93047°–38.93383°N, 95.21375°–95.21577°W, elev. 840–870 ft., 20.x.2012, on *B. delicata* on polished chert and glacial till, *C.A. Morse et al. 23806,* (KANU); NW side of Lawrence, City of Lawrence Nature Park, 38.98512°–38.98686°N, 95.29987°–95.30014°W, elev. 930–980 ft., 8.i.2012, on *Bacidina* sp. on chert, *C.A. Morse 23255 & K.J. Morse* (KANU); ca 5 mi N, 2 mi E of Lawrence, Fitch Natural History Reservation, Henry S. Fitch Nature Trail, 39°02.41′N, 95°11.87′W, elev. 955 ft., 6.x.2002, on *B. egenula* on limestone, *N. Wilson L-396* (KANU)*, N. Wilson L-397* (KANU); 1.75 mi S, 6.75 mi E of Williamstown, University of Kansas Ecological Reserves, Fitch Natural History Reservation, along gravel drive from E 1600 Rd to trailhead, 39.04001°N, 95.20181°W, elev. 900–925 ft., 23.x.2013, on *Bacidina* sp. on *Gleditsia triacanthos* bark, *C.A. Morse 24047 & H.S. Morse* (KANU), on *B. egenula* on chert, *C.A. Morse 24059 & H.S. Morse* (KANU); ca 0.25–0.45 mi N, 1.75 mi E jct of DG Co Rd 1055 & US Hwy 56 in Baldwin City, property of Ralph & Roma Earles, 38.78507°–38.78936°N, 95.15189–95.15539°W, elev. 970–1060 ft., 26.ii.2012, on *B. delicata* on sandstone, *C.A. Morse 23264 & K.J. Morse* (KANU); 1.75 mi N, 0.5 mi W of jct of US Hwy 56 & DG Co Rd 1055 in Baldwin City, University of Kansas Ecological Reserves, Breidenthal Biological Reserve, 38.80877°N, 95.19013°W, elev. 960–1070 ft., 20.ii.2011, on *Bacidina* sp. on sandstone, *C.A. Morse 22279 & K. Logan* (KANU); 0.5 mi S of Stull, Clinton Lake Wildlife Area, along NW arm of lake, 38.96331°N, 95.45338°W, elev. 900–970 ft., 24.xi.2012, on *B. delicata* on rotting wood, *C.A. Morse et al. 23859* (KANU); ca 2.75 mi S, 1.25 mi E of Stull, W side of Clinton Reservoir, Woodridge Public Use Area, 38.9290°–38.93110°N, 95.43555°–95.43411°W, elev. 890–1000 ft., 11.xii.2011, on *B. delicata* on fallen branch, *C.A. Morse 23207 & K.J. Morse* (KANU), on *B. delicata* on polished chert, *C.A. Morse 23208 & K.J. Morse* (KANU). JEFFERSON CO.: ca 0.75–1 mi S, 6.75–7.25 mi E of Williamstown, University of Kansas Ecological Reserves, Nelson Environmental Study Area and Rockefeller Experimental Tract, units 4008, 4013, and 4018, 39.05321°–39.05708°N, 95.20457°–95.19743°W, elev. 1030–1080 ft., 28.viii.2011, on *B. delicata* on chert, *C.A. Morse 23067 & K.J. Morse* (KANU). LEAVENWORTH CO.: ca 2 mi E, 1 mi S Easton, Shantivanam House of Prayer, Peace Forest, 39°19.25′N, 95°05.31′W, elev. 1030 ft., 9.x.2002, on *B. egenula* on limestone, *N. Wilson L-672* (KANU), 39°19.14′N, 95°05.60′W, elev. 970 ft, 7.ix.2002, on *B.* ***egenula*** on limestone, *N. Wilson L-666* (KANU); Fort Leavenworth Military Reservation, W-central part, 39.36220°–39.36878°N, 94.93345°–94.93372°W, elev. 850–1000 ft., 14.v.2008, on *B. delicata vel aff.* on rotting *Quercus* log, *C.A. Morse 16477* (KANU). LINN CO.: ca. 2 mi S, 2.75 mi E of Trading Post, Marais des Cygnes National Wildlife Refuge, 38.21633°N, 94.63616°W, elev. 780–810 ft., 1.xii.2010, on *Bacidina* sp. on polished chert, *C.A. Morse 22157 & T. Menard* (KANU). SHAWNEE CO.: ca. 0.75 mi S of Willard, Herbert Reinhard Green Memorial Wildlife Area, 39.08371°–39.08522°N, 95.93825°–95.94215°W, elev. 920–1030 ft., 21.viii.2010, on *B. egenula* on polished chert and glacial till, *C.A. Morse 21507 & K. Logan* (hb. Ladd, KANU, NY). WOODSON CO.: 6 mi E Toronto, Woodson Co State Fishing Lake & Wildlife Area on SE side, 37°47′37–42″N, 95°50′27–07″W, elev. 980–1030 ft., 8.iii.2004, on *B. delicata* on sandstone, *C.A. Morse 10247b & J.F. Morse* (KANU). **MISSOURI.** BUCHANAN CO.: 0.5 mi N, 2.5 mi E Halls, Bluffwoods Conservation Area, along Forest Nature Trail, 39.63505°–39.63710°N, 94.92795°–94.93162°W, elev. 920–1050 ft., 6.vi.2008, on *Bacidina* sp. on fine-grained limestone, *C.A. Morse 17367 & D. Ladd* (KANU). **OKLAHOMA.** COMANCHE CO.: ca 4.25 mi N, 2–2.5 mi W of Cache, Wichita Mountains Wildlife Refuge, N side of Eagle Mountain and vicinity of The Narrows, 34.69980°–34.70002°N, 98.67162°–98.67664°W, elev. 1400–1550 ft., 14–15.iv.2010, on *Bacidina* sp. on *Quercus stellata* bark, *C.A. Morse 20563f* (KANU).

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